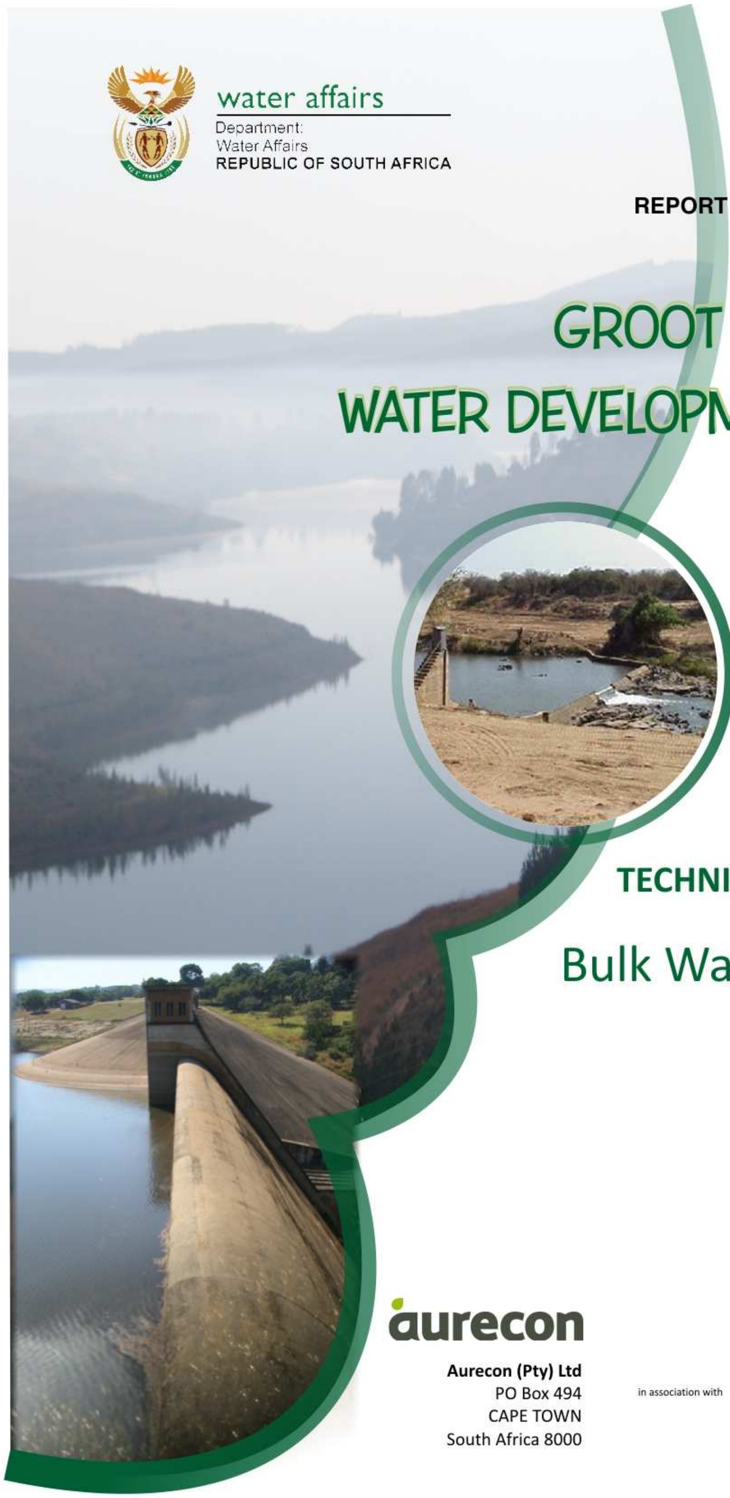
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

REPORT NO.: P WMA 02/B810/00/0608/8

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT (GLeWaP)



TECHNICAL STUDY MODULE:

Bulk Water Distribution Infrastructure

VOLUME 8

MAY 2010

aurecon

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Schoeman & Associates

W52_2010/H505701

LIST OF STUDY REPORTS IN GROOT LETABA RIVER WATER DEVELOPMENT PROJECT (BRIDGING STUDIES)

This report forms part of the series of reports, done for the bridging studies phase of the GLeWaP. All reports for the GLeWaP are listed below.

REPORT NUMBER	REPORT TITLE
P WMA 02/B810/00/0508	**Project Coordination and Management Team**
P WMA 02/B810/00/0508/1	Project Coordination and Management Team: Executive Summary Report: Vol 1
P WMA 02/B810/00/0508/2	Project Coordination and Management Team: Main Report: Vol 2
P WMA 02/B810/00/0508/3	Project Coordination and Management Team: Register of Decisions: Vol 3
P WMA 02/B810/00/0508/4	Project Coordination and Management Team
P WMA 02/B810/00/0508/5	Project Coordination and Management Team
P WMA 02/B810/00/0608	**Technical Study Module**
P WMA 02/B810/00/0608/1	Technical Study Module: Main Report: Vol 1
P WMA 02/B810/00/0608/2	Technical Study Module: Review of Water Requirements: Vol 2
P WMA 02/B810/00/0608/3	Technical Study Module: Groundwater: Vol 3
P WMA 02/B810/00/0608/4	Technical Study Module: Hydrology: Vol 4
P WMA 02/B810/00/0608/5	Technical Study Module: Water Resource Analysis: Vol 5
P WMA 02/B810/00/0608/6	Technical Study Module: Preliminary Design of Nwamitwa Dam: Vol 6
P WMA 02/B810/00/1110/1	Technical Study Module: Preliminary Design of Nwamitwa Dam: Vol 6 - Annexure 1: Appendices
P WMA 02/B810/00/1110/2	Technical Study Module: Preliminary Design of Nwamitwa Dam: Vol 6 - Annexure 2: Appendix B (Part 1): Geotechnical Investigations
P WMA 02/B810/00/1110/3	Technical Study Module: Preliminary Design of Nwamitwa Dam: Vol 6 - Annexure 3: Appendix B (Part 2): Geotechnical Investigations
P WMA 02/B810/00/1110/4	Technical Study Module: Preliminary Design of Nwamitwa Dam: Vol 6 - Annexure 4: Appendix H: Drawings
P WMA 02/B810/00/0608/7	Technical Study Module: Preliminary Design of the Raising of Tzaneen Dam: Vol 7
P WMA 02/B810/00/0608/8	Technical Study Module: Bulk Water Distribution Infrastructure: Vol 8
P WMA 02/B810/00/1110/5	Technical Study Module: Bulk Water Distribution Infrastructure: Vol 8 - Annexure 1 : Appendices
P WMA 02/B810/00/0708	**Environmental Management Module**
P WMA 02/B810/00/0708/1	Environmental Management Module: Scoping Report: Vol 1
P WMA 02/B810/00/0708/2	Environmental Management Module: Environmental Impact Assessment Report: Vol 2
P WMA 02/B810/00/0708/3	Environmental Management Module: Environmental Management Programme for Borrow Area 1 on the Farm Laborie 515: Vol 3
P WMA 02/B810/00/0708/4	Environmental Management Module: Environmental Management Programme for Borrow Area 2 on the Farm La Parisa 729 (Gubits Farm): Vol 4
P WMA 02/B810/00/0708/5	Environmental Management Module: Environmental Management Programme for Borrow Area 3 on the Farm Letaba Drift 727: Vol 5
P WMA 02/B810/00/0708/6	Environmental Management Module
P WMA 02/B810/00/0708/7	Environmental Management Module
P WMA 02/B810/00/0708/8	Environmental Management Module
P WMA 02/B810/00/0708/9	Environmental Management Module
P WMA 02/B810/00/0708/10	Environmental Management Module
P WMA 02/B810/00/0808	**Public Involvement Program**
P WMA 02/B810/00/0808/1	Public Involvement Program: Main Report: Vol 1
P WMA 02/B810/00/0808/2	Public Involvement Program
P WMA 02/B810/00/0808/3	Public Involvement Program
P WMA 02/B810/00/0808/4	Public Involvement Program
P WMA 02/B810/00/0808/5	Public Involvement Program

REPORT DETAILS PAGE

Project name:	***Groot Letaba River Water Development Project***
Report Title:	***Bulk Water Distribution Infrastructure : Volume 8***
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DWAF report reference no.:	***P02/B810/00/0608/8***
PSP project reference no.:	***401775***
Status of report:	***Final***
First issue:	***March 2009***
Final issue:	***May 2010***

PSP

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DEPARTMENT WATER AFFAIRS (DWA)

Approved for DWA by:

OJS van den Berg
Chief Engineer: Options Analysis North

L S Mabūda
Chief Director: Integrated Water Resources Planning

EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 *BACKGROUND TO PROJECT*

The catchment of the Groot Letaba River has many and varied land uses with their associated water requirements, for example commercial irrigation, commercial afforestation, tourism, as well as primary demands by the population in the catchment. The water resources available in the catchment are limited, and considerable pressure has been put on these resources in the past. This situation has been investigated at various levels by the Department of Water Affairs and Forestry (DWAF).

The first major study undertaken for this area was the Letaba River Basin Study in 1985 (DWAF, 1990), which comprised the collection and analysis of all available data on water availability and use, as well as future water requirements and potential future water resource developments. This was followed by a Pre-feasibility Study (DWAF, 1994), which was completed in 1994. The focus of the Pre-feasibility Study was the complete updating of the hydrology of the Basin. The next study undertaken was the Feasibility Study of the Development and Management Options (DWAF, 1998), which was completed in 1998.

The Feasibility Study proposed several options for augmenting water supply from the Groot Letaba River. These included some management interventions, as well as the construction of a dam at Nwamitwa and the possible raising of Tzaneen Dam. These options would enable additional water to be allocated to the primary water users, would allow the ecological Reserve to be implemented and could also improve the assurance of supply to the agricultural sector.

This Bridging Study was initiated by (then) DWAF in 2006 (now the Department of Water Affairs (DWA)) in order to re-assess the recommendations arising from the Feasibility Study in the light of developments that have taken place in the intervening 10 years.

The study area, shown in ***Figure E1****, consists of the catchment of the Groot Letaba River, upstream of its confluence with the Klein Letaba River. The catchment falls within the Mopani District Municipality, which is made up of six local municipalities. The four Local Municipalities, parts or all of which are within the catchment area, are Greater Tzaneen, Greater Letaba, Ba Phalaborwa and Greater Giyane. The major* *town in the study area is Tzaneen, with Polokwane the provincial capital city of Limpopo located just outside of the catchment to the West.*

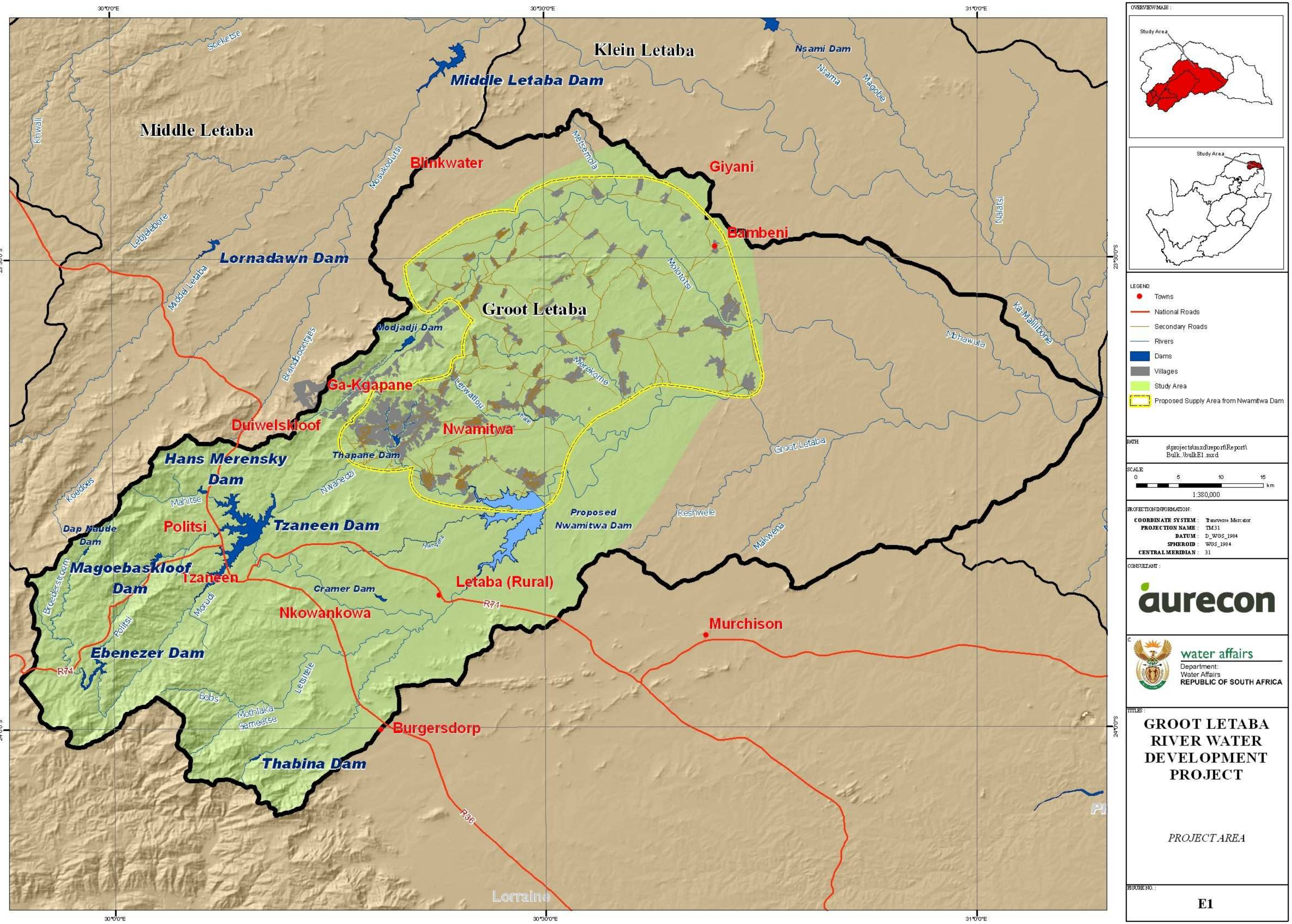
*The site of the proposed Nwamitwa Dam is also shown on **Figure E1**. The focus of the Feasibility Study was the Groot Letaba catchment, with the catchments of the other rivers being included to check that environmental flow requirements into the Kruger National Park were met, and international agreements regarding flow entering Moçambique were met. This focus was kept for this Bridging Study.*

1.2 SCOPE AND ORGANISATION OF PROJECT

The Department's Directorate: Options Analysis (OA), appointed Ninham Shand in Association with a number of sub consultants to undertake this study. In March 2009, Ninham Shand, Africon and Connell Wagner merged to become Aurecon.

The Bridging Study comprises a number of modules. This Report focuses on part of the scope of work for the Technical Study Module (TSM). The tasks comprising the TSM are: Water Requirements, Water Resource Evaluation, Preliminary Design of Nwamitwa Dam, Raising of Tzaneen Dam, Bulk Water Distribution Infrastructure, Implementation Programme and Water Quality.

This report describes Task 5 : Bulk Water Distribution Infrastructure.



Klein Letaba
Middle Letaba Dam
Nsami Dam
Middle Letaba
Blinkwater
Giyani
Bambeni
Lornadawn Dam
Groot Letaba
Modjadji Dam
Ga-Kgapane
Duiwelskloof
Nwamitwa
Thapane Dam
Hans Merensky Dam
Politsi
Tzaneen Dam
Dap Naude Dam
Magoebaskloof Dam
Tzaneen
Proposed Nwamitwa Dam
Cramer Dam
Letaba (Rural)
Nkowankowa
Murchison
Ebenezer Dam
Burgersdorp
Thabina Dam
Lorraine
R71
R74
R36
30°0'0"E
30°30'0"E
31°0'0"E
23°30'0"S
24°0'0"S
OVERVIEW MAPS :
Study Area
LEGEND
Towns
National Roads
Secondary Roads
Rivers
Dams
Villages
Study Area
Proposed Supply Area from Nwamitwa Dam
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SPHEROID : WGS_1984
CENTRAL MERIDIAN : 31
CONSULTANT :
aurecon
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA
TITLES :
GROOT LETABA RIVER WATER DEVELOPMENT PROJECT
PROJECT AREA
FIGURE NO. :
E1

2. SITUATION ASSESSMENT

2.1 EXISTING SUPPLY SCHEMES

The primary source of information pertaining to existing infrastructure was DWAF's, Limpopo Province, Mopani District Development Plan: DWAF Project LP 182, Book of Plans with Descriptive Details. This source of information was supplemented by a number of site visits and discussions with the operators of the existing infrastructure.

The following existing systems are located in close proximity to the proposed Nwamitwa Dam and could therefore be potentially supplied from the proposed Dam:

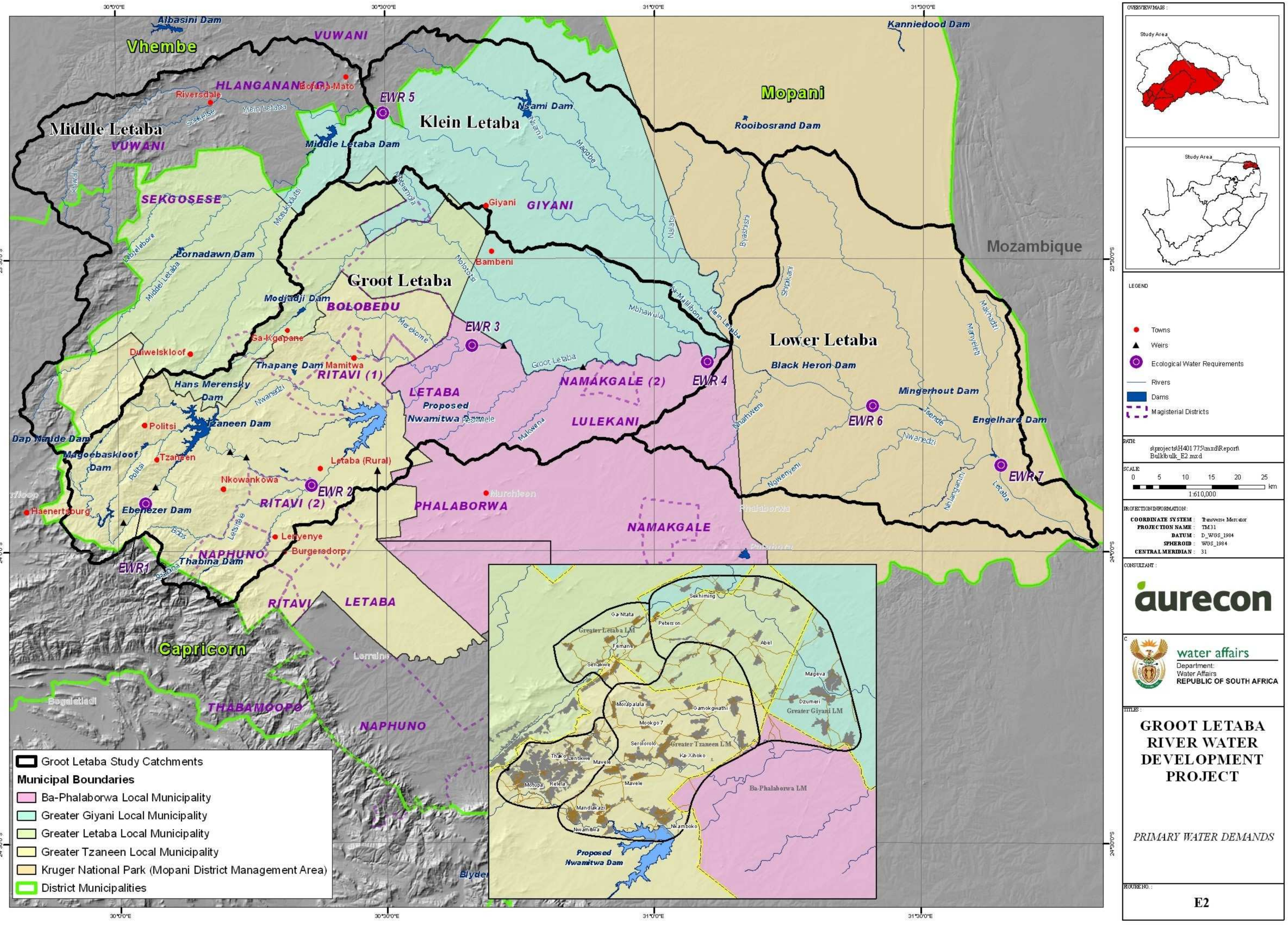
- *the Letaba Ritavi System*
- *the Thapane System*
- *the Modjadji System*
- *the Worcester/Mothobeki System*
- *the Lower Molototsi System*

For the purposes of this report, the Worcester/Mothobeki and Lower Molototsi systems are described as one System and is referred to in the documentation as the Worcester/Molototsi System

***Figure E1** shows the location of the four systems referred to above. The existing bulk water supply infrastructure is shown in **Figure E2**. Discussions were held with the owners and operators of each of the systems in order to get a good understanding of the operation of the existing infrastructure. From the discussions with the operators of the various systems it is evident that critical shortages of treated potable water exist in the Letaba, Thapane and Worcester/Molototsi systems. These water shortages can be attributed to insufficient water resources, the lack of bulk water infrastructure and incorrect pump type selection.*

2.2 EXISTING WATER TREATMENT WORKS

Surface water is currently pumped from a weir on the Letaba River, just downstream of the proposed Nwamitwa Dam. The raw water is treated at the Nkambako Water Treatment Works (WTW). The water treatment works comprises a single module with a capacity of 6 Mℓ/d. An identical second module is under construction, but has not yet been commissioned. After completion of the second module the plant will have a total capacity of 12 Mℓ/d.



Vhembe
Mopani
Capricorn
Mozambique
Middle Letaba
Klein Letaba
Groot Letaba
Lower Letaba
Albasini Dam
Middle Letaba Dam
Nsami Dam
Kanniedood Dam
Rooibosrand Dam
Lornadawn Dam
Modjadji Dam
Thapane Dam
Hans Merensky Dam
Tzaneen Dam
Dap Naude Dam
Magoebaskloof Dam
Ebenezer Dam
Thabina Dam
Black Heron Dam
Mingerhout Dam
Engelhard Dam
Proposed Nwamitwa Dam
EWR 1
EWR 2
EWR 3
EWR 4
EWR 5
EWR 6
EWR 7
VUWANI
HLANGANANI
SEKGOSESE
GIYANI
BOLOBEDU
RITAVI (1)
RITAVI (2)
LETABA
NAMAKGALE (2)
LULEKANI
PHALABORWA
NAMAKGALE
NAPHUNO
RITAVI
THABAMOOPO
Riversdale
Giyani
Bambeni
Sa-Kgapane
Mamitwa
Duiwelskloof
Politsi
Tzaneen
Nkowankowa
Letaba (Rural)
Haenertsburg
Lenyenye
Burgersdorp
Murchison
Greater Letaba LM
Greater Tzaneen LM
Greater Giyani LM
Ba-Phalaborwa LM
Groot Letaba Study Catchments
Municipal Boundaries
Ba-Phalaborwa Local Municipality
Greater Giyani Local Municipality
Greater Letaba Local Municipality
Greater Tzaneen Local Municipality
Kruger National Park (Mopani District Management Area)
District Municipalities
OVERVIEW MAPS :
Study Area
LEGEND
Towns
Weirs
Ecological Water Requirements
Rivers
Dams
Magisterial Districts
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CONSULTANT :
aurecon
water affairs
Department:
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REPUBLIC OF SOUTH AFRICA
TITLES :
GROOT LETABA RIVER WATER DEVELOPMENT PROJECT
PRIMARY WATER DEMANDS
FIGURE NO. :
E2

The treatment process at the WTW comprises of flocculation, sedimentation and filtration. Perusal of the plant records showed that treated water quality failed to meet SANS Class I requirements (the South African Bureau of Standards (SABS) sets out recommendations with respect to potable water in SANS 241-2006) and generally complies with the Class II requirements. With improved rapid mix of chemicals into the raw water, adequate sludge removal and repair of the filter backwash plant, the treatment works should be capable of producing a treated water in compliance with Class I requirements.

2.3 EXISTING GROUNDWATER USE

A desktop study (based on information in the GRIP database) was undertaken to ascertain the present use of groundwater in the study area as well as potential supply from groundwater. The census of groundwater infrastructure indicates that many of the regions which are not connected to the existing bulk water supply network, have access to enough groundwater to satisfy only the current basic survival demand of 16 litres/capita/day. The Thapane system and most of the Letaba system has access to bulk supplies from surface sources, augmented from groundwater. High yielding boreholes are not homogeneously distributed throughout the study area and are not always located close to villages with a high demand.

Another important consideration is that of borehole water quality. The DWAF water quality guidelines were used as a basis for determining the water quality requirements for different users. Most of the good quality groundwater is found in the relatively wetter western part of the study area. The north-eastern part of the region, namely the villages in the Worcester/Molototsi system rely on boreholes yielding Class III and IV water, which is unsuitable for potable use. Elevated concentrations of calcium and magnesium are in most cases responsible for the poor water quality. There are also boreholes which are sited in villages and are consequently contaminated with nitrates from nearby pit latrines. These nitrate contaminated boreholes can be rehabilitated with a sanitary seal, but the elevated levels of calcium and magnesium (caused by geological structures) will need water treatment.

The boreholes situated outside the villages have dedicated pipelines supplying central storage tanks. These boreholes were installed to target geological shear or fault zones and, as such, are more reliable, both in terms of yield and water quality.

3. *INFRASTRUCTURE NEEDS*

3.1 *WATER REQUIREMENTS*

*The future water requirements for all the rural settlements in the Study Area were supplied to the Study Team by EVN Africa. EVN Africa were appointed by the Department of Water Affairs (study entitled: Nwamitwa RWS: LPR 006) to assess the water requirements of the area taking into account inter alia service levels, socio economic development, water losses and the type of development. The estimated water requirements were derived from the population data within each settlement and a water requirement in litres/capita/day related to the level of service delivered. Information on the population projections and future water requirement projections per settlement per service level is given in **Appendix A** of this Report. A summary of the anticipated water requirements for the Study area is given in **Table E1**. The total water requirement from the proposed Nwamitwa Dam is estimated to be 11.2 Mm^3/a in 2027 when a higher level of service should be provided.*

Table E1 Future water requirements in the study area

	Water Requirements for different Service Levels (Mm^3/a)								
	Survival			**Standard**			**Higher**		
	2007	**2012**	**2027**	**2007**	**2012**	**2027**	**2007**	**2012**	**2027**
Letaba Ritavi	1.6	1.8	2.1	2.7	3.2	3.9	3.7	4.3	5.2
Thapane	0.9	1.0	1.3	1.6	1.9	2.4	2.1	2.6	3.3
Less Thapane Source	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Thapane *				0.1	0.4	0.9	0.6	1.1	1.8
Worcester +Lower Molototsi	0.6	0.7	0.8	1.1	1.2	1.4	1.5	1.6	1.9
Greater Giyani	0.5	0.6	0.9	0.9	1.0	1.7	1.2	1.4	2.3
TOTAL	**2.7**	**3.0**	**3.7**	**4.7**	**5.8**	**7.9**	**7.0**	**8.4**	**11.2**

Note : Excludes the 1.5 Mm^3/a demand already supplied from Thapane Dam

***Table E2** below shows the expected shortfall in the Modjadji system.*

Table E2 Supply to the Modjadji System

	Water Requirements for different Service Levels (Mm3/a)								
	Survival			**Standard**			**Higher**		
	2007	**2012**	**2027**	**2007**	**2012**	**2027**	**2007**	**2012**	**2027**
Modjadji water requirements	1.4	1.7	2.4	2.6	3.2	4.8	3.5	4.3	6.4
Supply available from Modjadji Dam	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Modjadji shortfall	--	--	--	--	--	**0.5**	--	--	**2.1**

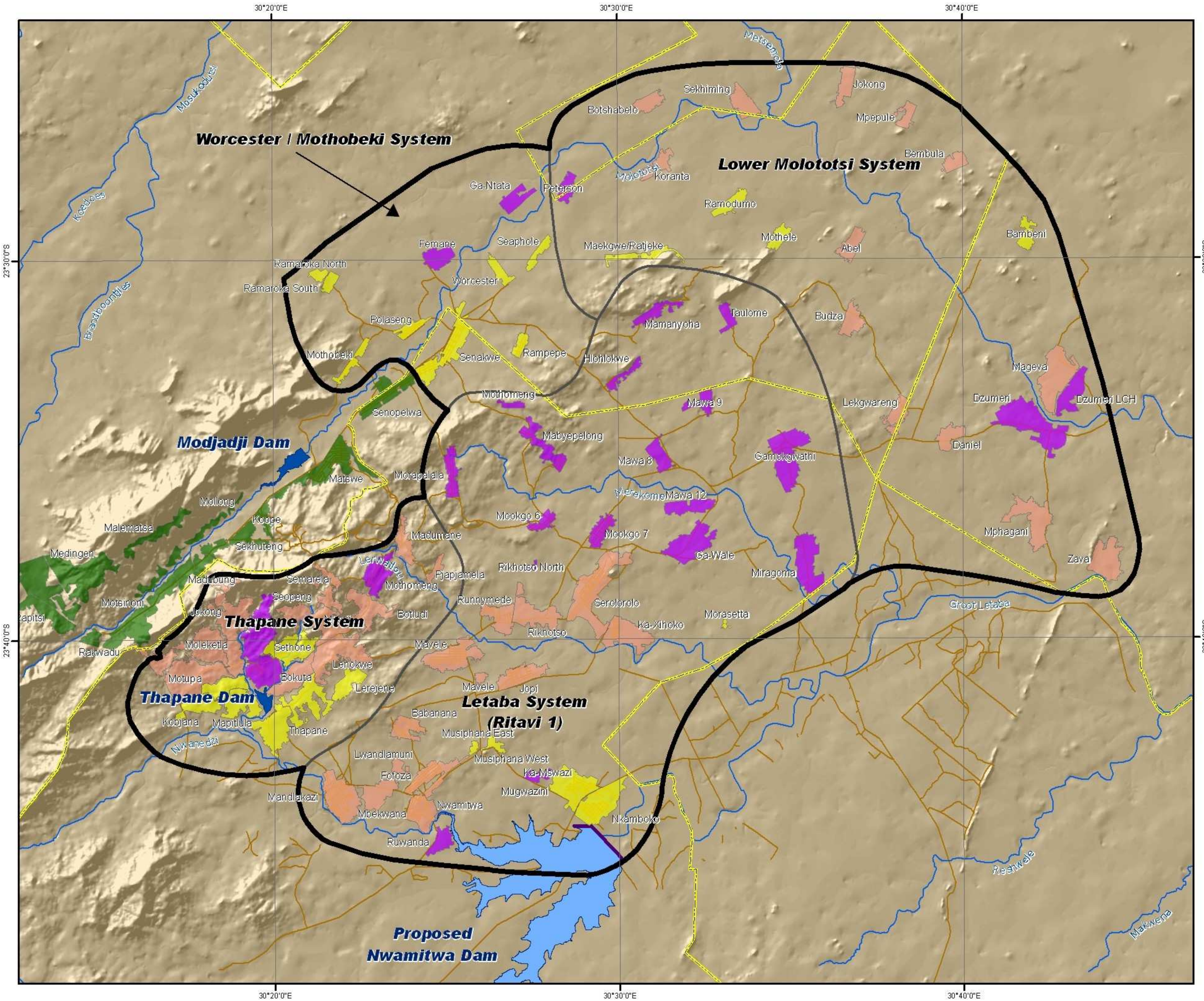
The total requirement from the proposed Nwamitwa Dam could be increased by 2.1 million m^3/a to 13.3 million m^3/a if the potential shortfall in the Mojadji system were to be supplied from Nwamitwa Dam in 2027.

3.2 LOGICAL SUPPLY AREA

In order to determine the logical area for the proposed Nwamitwa Dam the water requirements in the areas immediately surrounding the proposed dam were analysed and then compared to the anticipated yield from the proposed Nwamitwa Dam. The water resource analysis (DWA, 2010a) indicates that 13 Mm^3/a could safely be supplied from Nwamitwa Dam at a 98% level of assurance for domestic use. The anticipated 2027 domestic water requirement in the Letaba/Ritavi, Thapane and Worcester/Molototsi (including part of Giyani) supply areas is 11.2 Mm^3/a. This can be supplied from the yield of 13 Mm^3/a which was determined for a dam with a Full Supply Level of 479.5 masl. It is proposed that water ultimately intended for use in the Worcester/Molototsi System be used in the interim to supplement any future shortfalls in the Modjadji system prior to the full high water requirement being required in the Worcester/Molototsi system.

The villages Daniel, Dzumeri, Nogeva, Mphagani and Zava which should be supplied by the Giyani sub-system are included in the logical supply area, as these villages currently receive no potable water because of infrastructure capacity constraints and inadequate supplies. These villages currently rely solely upon groundwater.

Figure E.3 *shows the logical supply area to be served from Nwamitwa Dam and the current water availability in each settlement. The settlements identified as "water critical" have limited or poor groundwater supply and either no bulk water supply infrastructure or bulk supply infrastructure which is not utilised. The settlements identified as "water poor" have limited or poor groundwater supply and limited or rationed access to potable water.*



LEGEND

- Rivers
- Secondary Roads
- Proposed Dam Wall
- Dams
- Proposed Supply Areas of Nwamitwa Dam
- Municipality Boundaries

Villages

- Access to water
- Critical
- Villages outside study area
- Poor

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CONSULTANT:

aurecon

CLIENT:

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

TITLE:

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT

Logical Supply Area

FIGURE NO.

E3

4. INFRASTRUCTURE MASTER PLAN

Once the logical supply area was defined, the next step was to determine where to site the Regional Bulk Water Command Reservoirs, which areas the command reservoirs should serve and what the capacity of the command reservoirs should be. The ability to supply water under gravity, the flexibility of supply and system redundancy (for future system expansion) were primary considerations when deciding where to site the command reservoirs.

4.1 COMMAND RESERVOIRS

Currently all the supply systems include a number of village reservoirs as well as a few main regional reservoirs. The purpose of the regional reservoirs (or command reservoirs) is to provide balancing storage as well as emergency storage in the case of a disruption of supply.

It is proposed to provide bulk command reservoirs in the Worcester/Molototsi system (including a service to parts of the Giyani system), Thapane and Letaba/Ritavi systems by constructing two new command reservoirs. Two existing regional supply reservoirs, namely the 5 Mℓ reservoir at Serolorolo (command reservoir A) and the 7 Mℓ reservoir at Babanana (command Reservoir B) should be utilised as command reservoirs. The proposed two new command reservoirs are at an elevation high enough to feed the supply area under gravity. For this reason the command reservoirs are capable of supplying villages outside their respective supply areas which adds redundancy, and also reliability, to the system.

4.2 PIPELINES AND PUMP STATIONS

Existing pipelines from the Nkambako WTW were designed to cater for the Letaba system only. Linking of the three systems will require the installation of additional bulk water pipeline capacity and the upgrading of clear water pumps. It is proposed that two new bulk pipelines be constructed, one from Nkambako WTW to the existing Babanana command reservoir (command Reservoir B) and the other from Nkambako WTW to the existing Serolorolo Command Reservoir (command reservoir A). A pipeline with a booster pump station is proposed to link the Babanana command reservoir and the proposed Mohlakong regional reservoir in Thapane. The existing 300 mm diameter pumping main from the Nkambako WTW will be dedicated to supply the regional reservoir at Runnymede.

The Worcester/Molototsi system (including parts of the Giyani supply area) has to be linked by new pipelines from Serolorolo command reservoir to the proposed command reservoirs, C and D. These reservoirs will then feed into Worcester/-olototsi through the Worcester/Mothobeki and the Giyani supply systems.

The existing clear water pumps at Nkambako WTW cannot supply the combined system and it is therefore proposed that new pumping capacity be provided to serve the Babanana command reservoir and another for the Serolorolo command reservoir, and that the existing pumps be used to serve the Runnymede regional reservoir. There is also a need for a rising main with pump station to supply the proposed command reservoir C north-west of the village of Hlohlokwe from the command reservoir at Serolorolo. Command reservoir D, situated to the north-east of Gamokgwathi, can be fed by the bulk water gravity main from the existing command reservoir at Serolorolo.

4.3 Water Treatment Works

In order to satisfy the anticipated growth in future peak week water requirements, the Nkambako WTW will ultimately have to be expanded to a capacity of approximately 45 Mℓ/d. This will enable the WTW to meet the peak week water demand in 2027. It is important for Mopani District Municipality to meter and monitor the actual water usage to enable them to plan for the timely expansion of the Nkambako WTW in a modular fashion.

5. PRELIMINARY DESIGN OF BULK INFRASTRUCTURE

The analysis of the existing networks was done with reference to the current DWAF guidelines entitled "Technical guidelines for planning and design in the development of water and sanitation services" (DWAF, 2004). The DWAF technical guidelines were also checked against the recommendations made in the definitive publication on urban planning and infrastructure standards, Guidelines for human settlement planning and design (Department of Housing, 2000).

5.1 Command Reservoirs

An analysis was undertaken to determine the available storage in hours, based on the standard and high water requirement for 2007 and 2027. It is proposed that the two new command reservoirs C and D be sized at 5 Mℓ. This would ensure compliance with the requirement to provide approximately 48 hours of storage in the reticulation system in the case of a pumped supply with one source and approximately 36 hours of storage in the reticulation system in the case of a pumped *supply with two sources. This capacity is also comparable to the existing 5 Mℓ Reservoir at Serolorolo and the existing 7 Mℓ Reservoir at Babanana.*

5.2 PIPELINES AND PUMP STATIONS

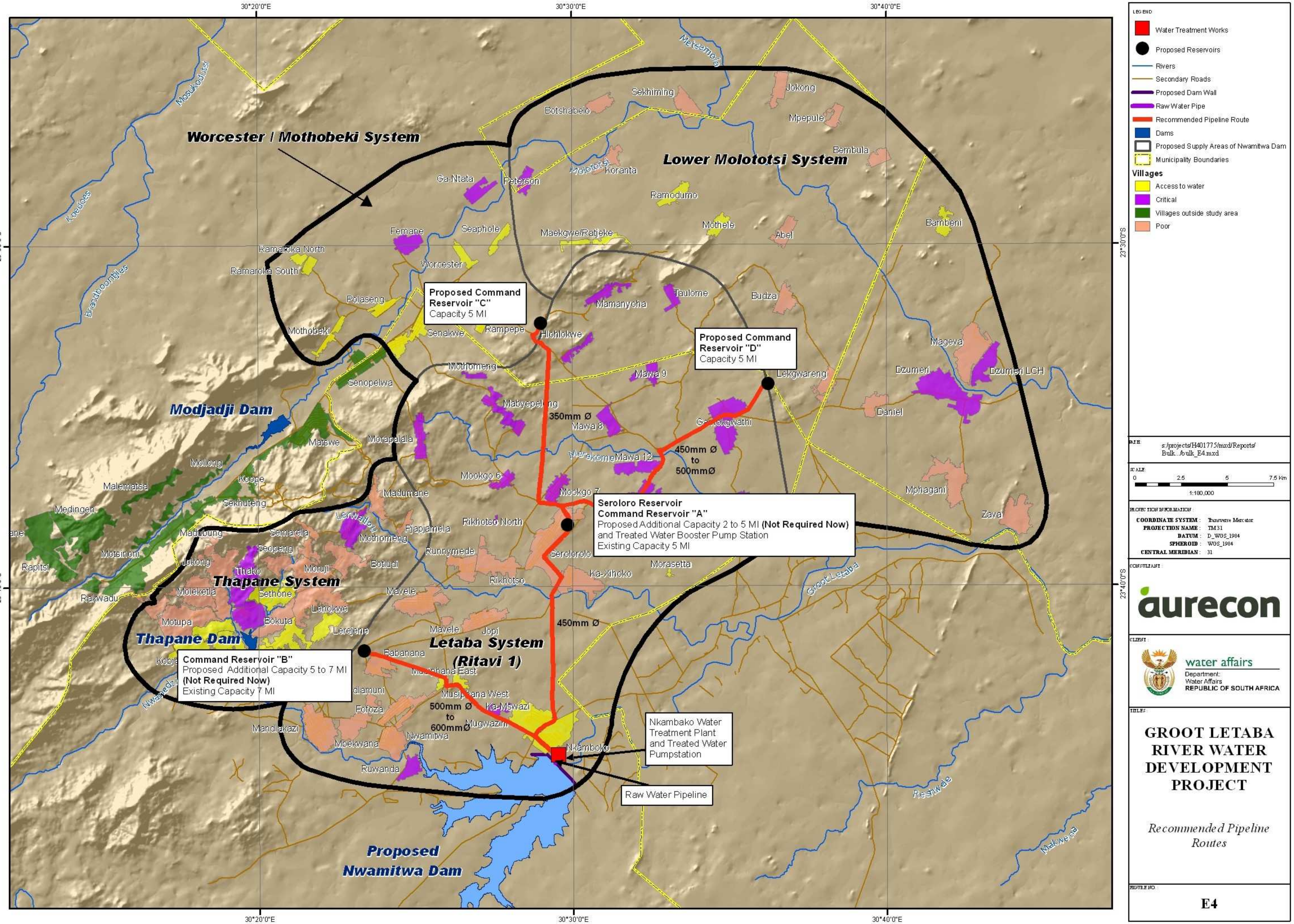
Various pipeline routes to each of the command reservoirs were identified and evaluated to determine the most economical options, taking factors such as capital costs (mainly a function of pipeline length), operating costs (influenced by pumping head and pipe friction), maintenance costs, and operational aspects (e.g. access to pipeline route) into account.

Peak week factors of 1,5 and 2,0 were applied to the AADD for the bulk water rising and gravity mains respectively. The peak week factor of 1,5 used for the rising mains includes provision for pumping 20 hours per day.

Pumping systems were optimised on the basis of the present value of capital, operating and maintenance costs of each pipeline for different pipeline diameters for the 2027 demand scenarios.

A preferred pipeline route was selected to each of the command reservoirs, based on the optimisation for the 2027 demand scenario. The optimisation process was then repeated for the 2008 demand scenario to determine the optimum pipeline diameter required in the short-term. This was used as a basis for evaluating the possibility of phasing the construction of infrastructure. The cost functions used for calculating the capital cost of the pumps and associated mechanical and electrical equipment were based on multi-stage centrifugal pumps.

The preliminary design of new works takes account of, the capacity of existing infrastructure, such as pumps and pipelines. Based on the good working condition of existing pumps, it is preferable to utilise the existing infrastructure as far as possible. The proposed pipeline routes are shown in ***Figure E4****.*



30°20'0"E
30°30'0"E
30°40'0"E
23°30'0"S
23°40'0"S
Worcester / Mothobeki System
Lower Molototsi System
Thapane System
Letaba System (Ritavi 1)
Modjadji Dam
Thapane Dam
Proposed Nwamitwa Dam
Proposed Command Reservoir "C"
Capacity 5 Ml
Proposed Command Reservoir "D"
Capacity 5 Ml
Seroloro Reservoir
Command Reservoir "A"
Proposed Additional Capacity 2 to 5 Ml (Not Required Now)
and Treated Water Booster Pump Station
Existing Capacity 5 Ml
Command Reservoir "B"
Proposed Additional Capacity 5 to 7 Ml
(Not Required Now)
Existing Capacity 7 Ml
Nkambako Water
Treatment Plant
and Treated Water
Pumpstation
Raw Water Pipeline
350mm Ø
450mm Ø
450mm Ø to 500mmØ
500mm Ø to 600mmØ
Groot Letaba
Molototsi
Merekome
Mosukodutsi
Nwanedzi
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Recommended Pipeline Route
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Municipality Boundaries
Villages
Access to water
Critical
Villages outside study area
Poor
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SPHEROID: WGS_1984
CENTRAL MERIDIAN: 31
CONSULTANT:
aurecon
CLIENT:
water affairs
Department: Water Affairs
REPUBLIC OF SOUTH AFRICA
TITLE:
GROOT LETABA RIVER WATER DEVELOPMENT PROJECT
Recommended Pipeline Routes
FIGURE NO.:
E4

5.3 *WATER TREATMENT WORKS*

The Nkambako WTW has a capacity of 12 Mℓ/d (including the recently constructed 6 Mℓ/d extension). In view of the uncertainty associated with the current and future water requirements it is proposed that any future upgrading be undertaken in increments of 12 Mℓ/d. The High Level Service water requirement scenario indicates that the capacity of the WTW (based on peak week water requirements) should be 45 Mℓ/d in 2027. This water requirement assumes that all the settlements in the logical supply area of the proposed Nwamitwa Dam have installed reticulation networks down to village level.

The treated water must comply with the SANS Class I specification. It is noted that some limited urban development exists within the catchment of the proposed dam and is close to the high water mark. It can therefore be expected that raw water quality will decline over time, particularly as regards to orthophosphate and nitrate, and that a degree of eutrophication may occur in the future. It is recommended that adequate sanitation be provided by the Water Services Authority in order to limit the danger of bacteriological contamination of the water source.

The following long-term water quality changes may occur in the proposed Nwamitwa Dam: slightly lower pH, increase in dissolved metals, (Fe and Mn in bottom water), increase in organic carbon associated with algae, possible increase in turbidity and TDS, and possible increase in e-coli. It is therefore important that the water treatment process be designed for the possible long term water quality that can be expected.

5.4 *RAW WATER PIPELINE AND PUMP STATION*

The existing raw water balancing dam at the WTW has a full supply level of approximately 474 m, whereas the operating level in the Nwamitwa Dam is likely to fluctuate from 470 m (i.e. 15% full) to 479,5 m (i.e. full supply level). It is therefore necessary to design the system to allow the filling of the balancing dam under gravity when the water level in the Nwamitwa Dam is high enough. Pumping is necessary when the water level in Nwamitwa Dam is lower than that in the balancing dam.

It would not be possible to locate the pump station at the Nwamitwa Dam, as the fluctuating water level makes it impossible to cover the complete operating range in flows (even when equipping the pumps with variable speed drives). The control of the switching from gravity to pumping mode, and vice versa, would also be complicated.

The preferred method of operation would be a hydraulically controlled system whereby the existing balancing dam would be filled under gravity when the water level in the Nwamitwa Dam is above 474 m, and a new balancing dam with a full supply level at 465 m to 467 m is filled when the water level in Nwamitwa Dam drops below 474 m. Water would then be pumped from the lower balancing dam to the existing balancing dam against a fixed head. This option would be suitable for fixed speed motors and would simplify the stopping and starting of the pumps, which would be regulated by the water level in the existing balancing dam.

The main criterion for selecting a suitable pipeline route is that the invert level of the pipeline must remain below a level of 464 m to enable flow to gravitate to the proposed second balancing dam.

It is recommended that a 600 mm diameter pipeline be installed from the Nwamitwa Dam to the existing and the proposed balancing dams.

It is proposed that the new balancing dam be sized for 2 hours balancing capacity to prevent frequent stopping and starting of the pumps. A balancing capacity of 3 780 m^3 would thus be required for a peak demand of 525 ℓ/s. Based on a depth of 2 m, the surface area would be approximately 45 m x 45 m.

5.5 Groundwater Use

A large number of villages in the supply area are reliant on groundwater. Many of the boreholes, however, deliver water of poor quality and require treatment before use. Blending poor quality borehole water with good quality water from surface water sources to dilute the high concentrations of solutes is one method of utilising the existing groundwater supply which was investigated.

The following groundwater use scenarios were investigated:

- *Utilisation of existing groundwater supply by means of blending*
- *Utilisation of all existing groundwater supply by means of treatment*
- *Utilisation of all Class 1 existing groundwater supply*
- *Utilisation of future groundwater supply by means of blending*
- *Full groundwater utilisation*

6. NWAMITWA RWS: CONCEPTUAL MASTER PLAN

*In parallel with the GLeWaP Bridging Study, DWA appointed EVN Africa (EVN) to undertake a bulk water supply planning assignment for the area surrounding the proposed Nwamitwa Dam. In order to ensure integration between the two studies, EVN utilised the services of Aurecon to develop a conceptual master plan for the bulk distribution system. The conceptual master plan integrated the planning of the GLeWaP Regional Bulk Water Supply Infrastructure with the planning of the "Connector" Bulk Water Supply Infrastructure. The "connector" bulk water supply infrastructure links the command reservoirs identified in the GLeWaP Study with the water reticulation infrastructure in each settlement area. The Nwamitwa RWS Conceptual Master Plan Report is presented in **Appendix J** of this Report.*

7. TIMING AND PHASING OF PROPOSED INFRASTRUCTURE

It is evident that all three water supply systems in the area currently receive an inadequate supply of water. All the proposed infrastructure components will be required to satisfy the specified level of service at the planning horizon of 2027. Because of the lack of usage metering and effective water conservation and demand management, there is uncertainty regarding current and projected future water requirements. Therefore the implementation of the bulk connector infrastructure should proceed with caution. It is believed that there is an immediate need to implement certain components of new bulk regional infrastructure as proposed in this report.

The proposed timing and phasing of the bulk water supply infrastructure (both Regional and Connector Infrastructure) is based on the following considerations:

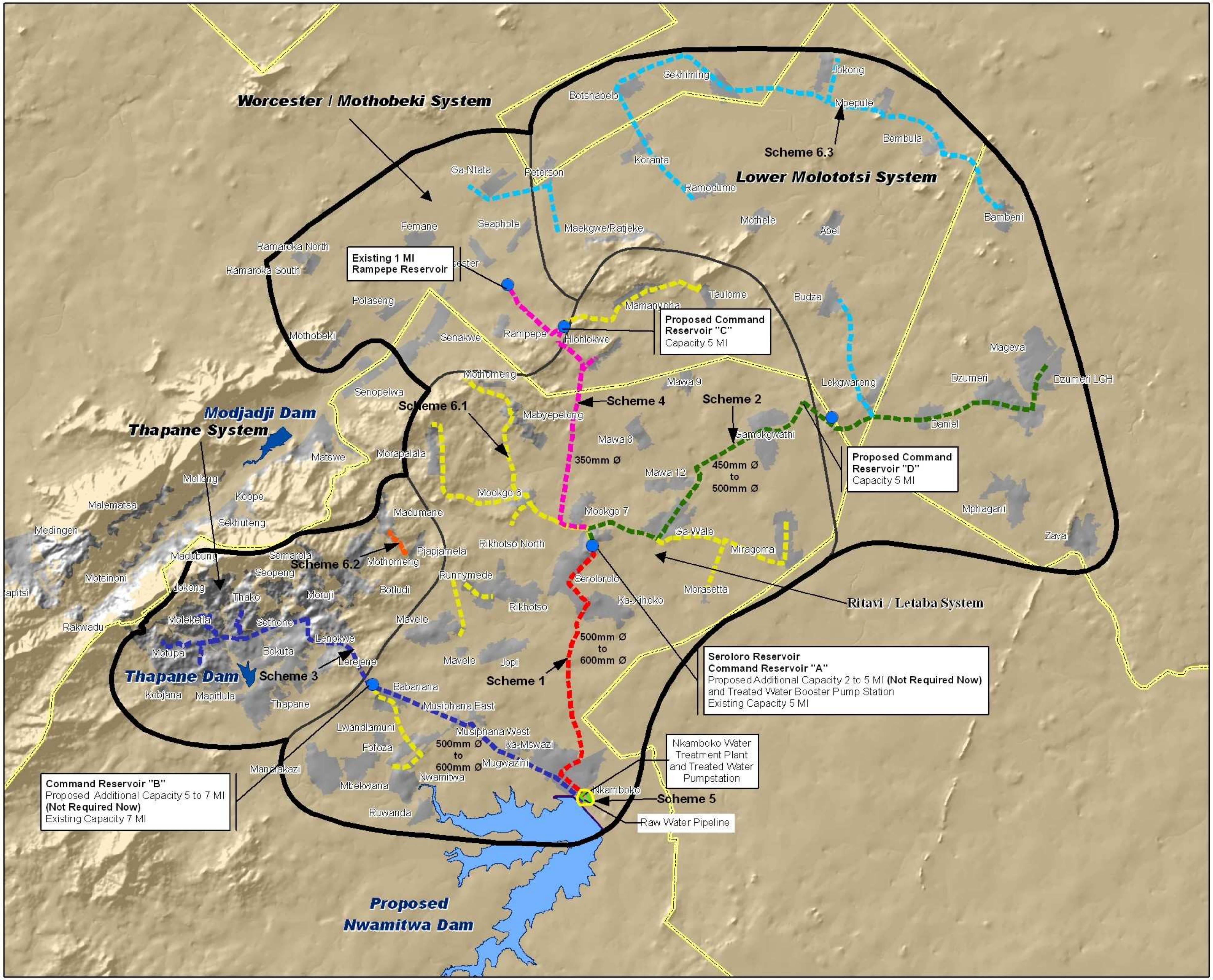
1) *The need to utilise existing unutilised bulk water supply infrastructure*

2) *The need to provide reliable water services to areas which currently receive no potable water*

3) *The need to augment water supplies to areas which currently experience water shortages and water rationing*

4) *The need to expand the water reticulation network to all settlements and villages.*

*A number of logical schemes have been conceptualized and are shown in **Figure E5**.*



LEGEND

- New Reservoirs
- Dams
- Villages
- Municipal Boundaries

Scheme

- 1 Supply to Seroloro Reservoir
- 2 Supply to Giyani
- 3 Supply to Thapane
- 4 Supply to Worcester/Molototsi
- 6.1 Bulk Connector : Ritavi
- 6.2 Bulk Connector : Thapane
- 6.3 Bulk Connector : Giyani

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CONSULTANT:

aurecon

CLIENT:

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

TITLE:

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT

Regional Water Supply Infrastructure: Proposed Schemes

FIGURE NO.

E5

It is estimated at the total cost to implement the proposed Regional Bulk Water Supply Infrastructure is approximately R313 million in 2009 terms.

8. CONCLUSIONS

The study confirmed that critical shortages of treated potable water exist in the Letaba, Thapane and Worcester/Molototsi systems. These water shortages can be attributed to insufficient water resources, the lack of bulk water infrastructure and incorrect pump type selection. In order to alleviate these shortages, it is imperative that the regional bulk water supply infrastructure as proposed in the recommendations of this report be implemented. It is important that the design of the regional bulk water supply infrastructure be integrated with the design of the bulk connector infrastructure in order to avoid unnecessary redundancies in the water supply system and to ensure that the most optimal design is obtained. There is uncertainty regarding the actual current and expected future water requirements in the area of supply of the proposed Nwamitwa Dam. It is therefore imperative that Mopani District Municipality ensure the metering and monitoring of all the proposed bulk water supply schemes. The expansion of the Nkambako WTW could be undertaken modularly as the water requirement increases in the future.

It is important to ensure that the recently constructed 355 mm Xihoko rising main is able to deliver water to the command reservoir at Serolorolo and that the Nkambako WTW is functioning at 12 Ml/d. Proposed modifications to this rising main have been made in this report and should be implemented as soon as possible. This will ensure that the existing bulk water infrastructure is fully utilised and certain villages that have not received potable water before will now be able to receive potable water.

Most of the good quality groundwater is found in the relatively wetter western part of the study area. The north-eastern part of the region, namely the villages in the Worcester/Molototsi system are being supplied from boreholes with Class III and IV water, which is unacceptable for potable use. Groundwater could potentially supply a significant portion of the future water requirements in the logical supply area of the proposed Nwamitwa Dam, either through blending with potable supplies or by onsite treatment prior to conveying it to the regional bulk water supply reservoirs. More detailed investigative studies are necessary in order to determine the full potential of and develop the groundwater in the area.

9. RECOMMENDATIONS

9.1 REGIONAL BULK WATER SUPPLY INFRASTRUCTURE

The following recommendations are made regarding the implementation of the regional bulk water supply infrastructure:

i) The Regional Bulk Water Supply Infrastructure as proposed should be implemented.

ii) The proposed timing and phasing of the bulk water supply infrastructure (both Regional and Connector Infrastructure) be based on the following considerations:

1) The need to utilise existing bulk water supply infrastructure to maximum capacity
2) The need to augment water supplies to areas which currently receive little or no potable water
3) The need to augment water supplies to areas which currently experience water shortages and water rationing
4) The need to expand the water reticulation network to all settlements and villages.

iii) The Nkambako WTW shall be designed to cater for the expected changes in the raw water quality in the long term.

iv) The following upgrades are recommended for the existing 355 mm Xihoko rising main:

- *Replace approximately 1 200 m of Class 6 PVC-U pipes with Class 9 pipes;*
- *Install two new pumps (i.e. one duty, one standby) at the WTW to feed the 355 mm rising main (i.e. the existing pumps are not suited for the required duty).*
- *Construct a sump at the suction side of the booster pump station or install a pressure relief valve.*

v) The Mopani District Municipality should implement a metering and monitoring system in order to ascertain the actual water consumption for domestic purposes and to establish how the requirement changes with the *implementation of the regional bulk water supply and connector bulk infrastructure.*

vi) *The capacity of the Babanana Reservoir (command reservoir B) and the Serolorolo Reservoir (command reservoir A) should be increased when the future water requirements reach the stage that there is insufficient emergency and balancing storage in the respective supply areas.*

vii) *Provision should be made for including water from a future regional groundwater supply system in the bulk infrastructure which stores and distributes treated water from surface sources.*

viii) *It is proposed that the regional bulk water supply infrastructure supplying the Worcester/Molototsi System be used to supplement the water requirement shortfall in the Modjadji system during off peak periods should it be required.*

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ABBREVIATIONS

AADD	Average annual daily demand
Ca	Calcium
CDRT	Constant discharge rate test
Cl	Chlorine
DNAPL	Dense non-aqueous phase liquids
DWAF	Department of Water Affairs and Forestry
EC	Electrical conductivity
EMM	Environmental Management Module
F	Fluorine
Fe	Iron
GLeWaP	Groot Letaba River Water Development Project
GRIP	Ground Water Information Project
IFM	Institutional and Financial Module
kℓ	Kilolitres
kℓ/d	kilolitres per day
kW	kilowatt
kWh	Kilowatt hours
ℓ	Litre
ℓ/c/d	litres per capita per day
ℓ/s	litres per second
m	Metre
masl	metres above sea level
Mg	Magnesium
mg/ℓ	milligrams per litre
mgN/ℓ	milligrams of Nitrate per litre
mgP/ℓ	milligrams of Phosphate per litre
Mℓ	Millilitres
mm	Millimetre
Mm^3	million cubic metres
Mm^3/a	million cubic metres per annum
m^3/h	cubic metres per hour
$m^3/m^2/h$	cubic metres per square metre per hour
MMI	Man machine interface
Mn	Manganese
Na	Sodium

NAPL	Non-aqueous phase liquids
NTU	Nephelometric turbidity units
OA	Options Analysis
PCMT	Project Co-ordination and Management Team
pH	Acidity of the water
PIP	Public Involvement Programme
PO_4	Ortho-phosphate
PSP	Professional Service Provider
rpm	revolutions per minute
RWS	rural water supply
SABS	South African Bureau of Standards
SANS	South African National Standards
SDD	Summer daily demand
SEE	Socio-economic Evaluation
SOP	Standard Operation Procedure
SPF	Summer peak factor
TDS	Total dissolved solids
THM	Trihalomethanes
TSM	Technical Study Module
µg/ℓ	micrograms per litre
US	United States
VAT	Value added tax
WSDP	Water Service Development Plan
WTW	Water Treatment Works

1. STUDY INTRODUCTION

1.1 BACKGROUND TO PROJECT

The catchment of the Groot Letaba River has many and varied land uses with their associated water requirements. These include significant use by agriculture in the form of irrigated crops, commercial afforestation, tourism (particularly linked to the Kruger National Park, which lies partially within the catchment), as well as primary demands by the population in the catchment. The water resources available in the catchment are limited, and considerable pressure has been put on these resources in the past, with periods of severe and protracted water restrictions occurring over the past 25 years. This situation has been investigated at various levels of detail by the Department of Water Affairs (DWA).

The first major study undertaken for this area was the Letaba River Basin Study in 1985 (DWAF, 1990), which comprised the collection and analysis of all available data on water availability and use, as well as future water requirements and potential future water resource developments. This was followed by a Pre-feasibility Study (DWAF 1994), which was completed in 1994. The focus of the Pre-feasibility Study was the complete updating of the hydrology of the Basin. The next study undertaken was the Feasibility Study of the Development and Management Options (DWAF, 1998), which was completed in 1998.

The Feasibility Study proposed several options for augmenting the water supply from the Groot Letaba River. These included some management interventions, as well as the construction of a dam at Nwamitwa and the possible raising of Tzaneen Dam. These options would enable additional water to be allocated to the primary water users, would allow the ecological Reserve to be implemented and could also improve the assurance of supply to the agricultural sector.

This Bridging Study was initiated by (then) Department of Water Affairs and Forestry in 2006 (now the DWA) in order to re-assess the recommendations arising from the Feasibility Study in the light of developments that have taken place in the intervening 10 years. Other contributing factors to the DWA's decision to undertake Bridging Studies were the promulgation of the Water Services Act and the National Water Act in 1997 and 1998 respectively, and the recently completed Reserve determined for the Letaba River.

The study area is shown in **Figure 1.1**, consisting of the catchment of the Groot Letaba River, upstream of its confluence with the Klein Letaba River. The catchment falls within the Mopani District Municipality, which is made up of six Local Municipalities. The four Local Municipalities, parts or all of which are within the catchment area are Greater Tzaneen, Greater Letaba, Ba Phalaborwa and Greater Giyani. The major town in the study area is Tzaneen, with Polokwane the provincial capital city of Limpopo located just outside of the catchment to the west.

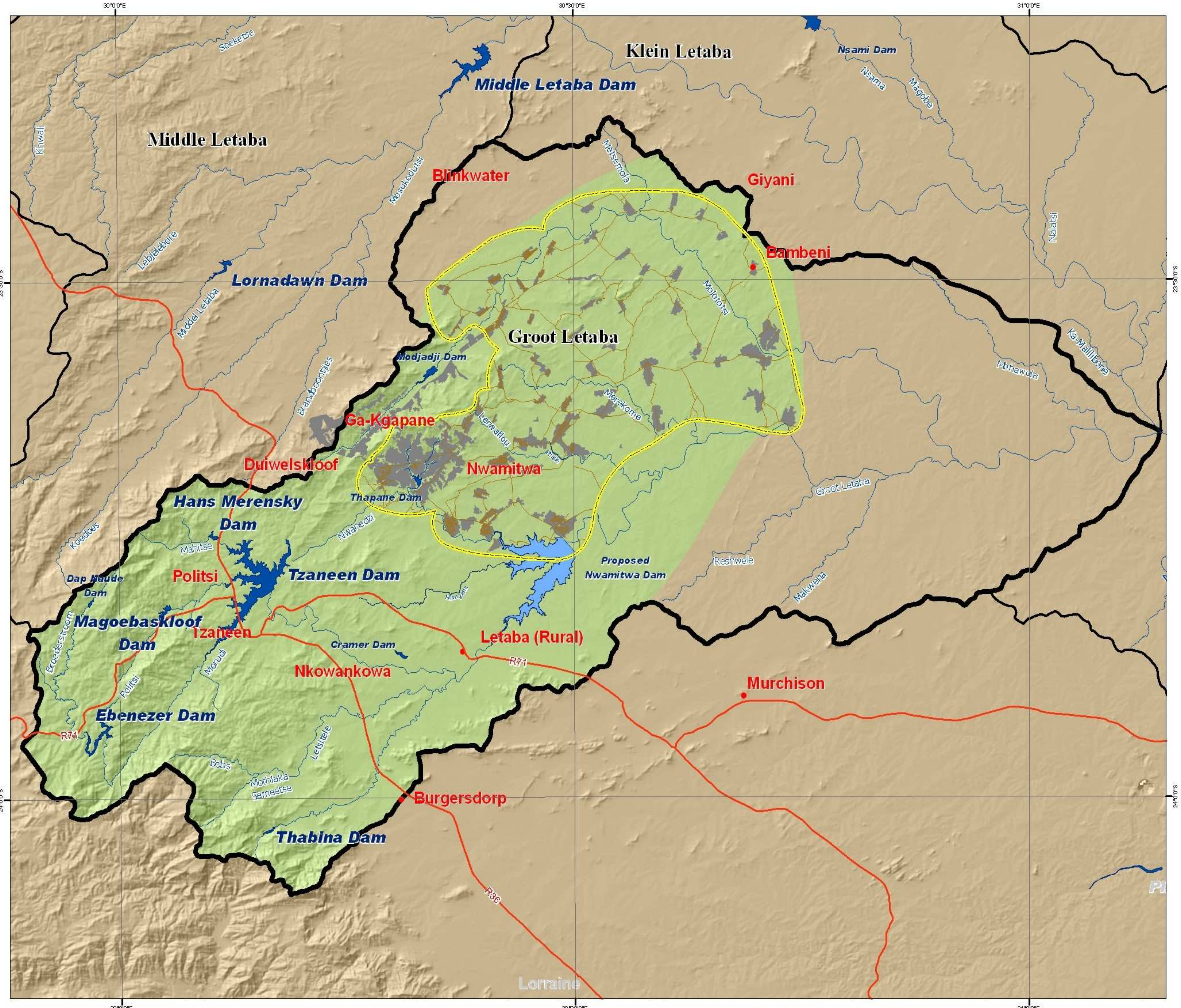
The site of the proposed Nwamitwa Dam is also shown in **Figure 1.1**. The focus of the Feasibility Study was the Groot Letaba catchment, with the catchments of the other rivers being included to check that environmental flow requirements into the Kruger National Park were met, and international agreements regarding flow entering Moçambique were met. This focus was kept for this Bridging Study.

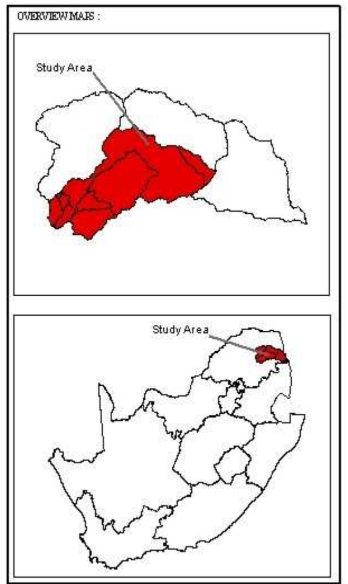
1.2 SCOPE AND ORGANISATION OF PROJECT

The Department's Directorate: Options Analysis (OA), appointed Ninham Shand in Association with a number of sub consultants (listed below) to undertake this study. In March 2009, Ninham Shand, Africon and Connell Wagner merged to become Aurecon. The official title of the study is: "The Groot Letaba Water Development Project: Bridging Studies: Technical Study Module".

An association exists between the following consultants for the purposes of this study:

- Aurecon
- Semenya Furumele Consulting
- KLM Consulting Services
- Urban-Econ Developmental Economists
- Schoeman & Vennote





LEGEND

- Towns
- National Roads
- Secondary Roads
- Rivers
- Dams
- Villages
- Study Area
- Proposed Supply Area from Nwamitwa Dam

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CONSULTANT :

aurecon

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

TITLES :

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT

PROJECT AREA

FIGURE NO. :

1.1

The Bridging Study comprises a number of modules, namely: an Environmental Management Module (EMM), a Public Involvement Programme (PIP), and a Technical Study Module (TSM). This Report focuses on part of the scope of work for the Technical Study Module (TSM).

The tasks comprising the TSM are summarised below:

TASK 1: WATER REQUIREMENTS

The objective of this Task is to:

- review the current estimates of future water requirements in all user sectors
- establish present levels of water use in these sectors
- assess the availability of ground water in the project area

TASK 2: WATER RESOURCE EVALUATION

The objective of this Task is to:

- Assess the present availability of surface water from the Groot Letaba River System
- Assess the increase in yield of the proposed new developments, taking account of the flow regime required to maintain the ecological Reserve

TASK 3: PRELIMINARY DESIGN OF NWAMITWA DAM

The objective of this Task is to:

- Determine the most suited dam type and position for the proposed Nwamitwa Dam
- Optimise the proposed development proposal
- Provide an updated estimate of the costs of implementing Nwamitwa Dam

TASK 4: RAISING OF TZANEEN DAM

The objective of this Task is to:

- Determine the benefits from raising Tzaneen Dam, in terms of water availability and security of supply
- Determine the optimum method of raising Tzaneen Dam
- Optimise the proposed development proposal
- Provide an updated estimate of the costs of raising Tzaneen Dam

TASK 5: BULK WATER DISTRIBUTION INFRASTRUCTURE

The objective of this Task is to:

- Assess infrastructure currently available to make bulk water supplies available to the rural areas
- Undertake conceptual planning for the areas to be supplied from Nwamitwa Dam
- Undertake a preliminary design and cost estimate for the proposed new bulk water distribution infrastructure

TASK 6: IMPLEMENTING PROGRAMME

The objective of this Task is to determine a realistic programme for the implementation of the proposed developments

TASK 7: WATER QUALITY

The objective of this Task is to undertake an in-lake water quality analysis of the proposed Nwamitwa Dam, to inform the design of the outlet structure of the dam

1.3 SCOPE OF THIS REPORT

This report describes Task 5 : Bulk Water Distribution Infrastructure. The content of the task is described in more detail below.

Sub Task: Situation Assessment
Sub Task: Infrastructure Needs
Sub Task: Conceptual Planning
Sub Task: Preliminary Design
Sub Task: Cost Estimates

The outcome of these sub tasks will assist the DWA in making a decision of which infrastructure components should be implemented as part of the GLeWaP and which infrastructure projects should be the responsibility of the Water Service Authority for the region to implement.

2. SITUATION ASSESSMENT

2.1 EXISTING INFORMATION AND STUDIES

Following discussions with representatives from the DWA, Mopani District Municipality and consultants employed by both the DWA and Mopani District Municipality, the following relevant sources of information were identified:

1. DWAF, Limpopo Province, Mopani District Development Plan: DWAF Project LP 182, Book of Plans with Descriptive Details (2003 -10-15)
2. Mopani District Municipality, DWAF, Directorate Water Services Macro Planning and Information Systems, Water Services Planning Reference Framework, Draft 2, March 2006.
3. EVN Database of Water Requirements
4. DWAF's Ground Water Information Project (GRIP)
5. Mopani District Municipality Water Services Development Plan 2007
6. Design Report for Letaba RWS, Xihoko Rising Main (July 2004)

A brief description of the three primary sources of information utilised to develop the conceptual masterplan as required under this study is given below:

DWAF, Limpopo Province, Mopani District Development Plan: DWAF Project LP 182, Book of Plans with Descriptive Details

This document contained schematic plans of the bulk pipelines and settlements served by the bulk infrastructure in the Mojadji / Letaba Rural Water Supply (RWS) Service Area. The schematic plans gave a conceptual layout of the proposed infrastructure required to extend the existing bulk reticulation infrastructure to all the settlements in the supply area. In addition to schematic layout plans, a brief write-up of each system within the Mojadji / Letaba RWS Service Area was also provided. The write-up contained summary information such as service level profile, water resource profile, Water Conservation and Demand Management, Water Services Infrastructure, Water Balance, Water Services Institutional Arrangements, Customer Services, Financial Information and a Project List. The Book of Plans was prepared for the Department of Water Affairs and Forestry by EVN Africa Consulting Services.

Mopani District Municipality, DWAF, Directorate Water Services Macro Planning and Information Systems, Water Services Planning Reference Framework, Draft 2, March 2006.

The Water Services Planning Reference Framework was developed by DWAF by utilising the Directorate Macro Planning and Information Systems GIS data to compile base maps to address specific topics. The Reference Framework was developed primarily to evaluate the Water Service Development Plans (WSDP) of Water Service Authorities. The Reference Framework Documents is also used to provide strategic support and information to Local Government and Water Service Providers and to assist these water service institutions in strategic planning and daily operations.

The Reference Frameworks contains information of the socio economic development, Service Level Development, Water Resource Development, Water Conservation and Demand Management, Water Services Infrastructure, Water Services Authority Institutional Arrangement, Customer Services, Financial Profile and Project Development.

The bulk water planning contained in the Reference Framework Document was based on the Book of Descriptive Plans developed for DWAF, as described above.

EVN Database of Water Requirements

EVN Africa (consultants appointed by the DWAF Limpopo Region) provided a database of water requirements for each settlement located within the area of supply of the proposed Nwamitwa Dam. The water requirements were categorised into different service levels, namely: basic, standard and high.

2.2 CURRENT SUPPLY AREAS

The following bulk water supply systems are operated within close proximity to the proposed Nwamitwa Dam and could therefore be potentially supplied from the Dam:

- the Letaba Ritavi System
- the Thapane System
- the Modjadji System
- the Worcester/Mothobeki System
- the Lower Molototsi System

For the purposes of this report, the Worcester/Mothobeki and Lower Molototsi systems are described as one System and is referred to in the documentation as the Worcester/Molototsi System

Figure 2.1 shows the location of the four systems referred to above. The existing bulk water supply infrastructure is shown in **Figre 2.2**. Discussions were held with the owners and operators of each of the systems in order to be able to get a good understanding of the operation of the existing infrastructure. From the discussions with the operators of the various systems it is evident that critical shortages of treated potable water exist in the Letaba, Thapane and Worcester/Molototsi System. These water shortages can be attributed to insufficient water resources, the lack of bulk water infrastructure and incorrect pump type selection. A description of the system, its current mode of operation and the problems being experienced in each of the systems is described in detail below.

2.2.1 Letaba/Ritavi System

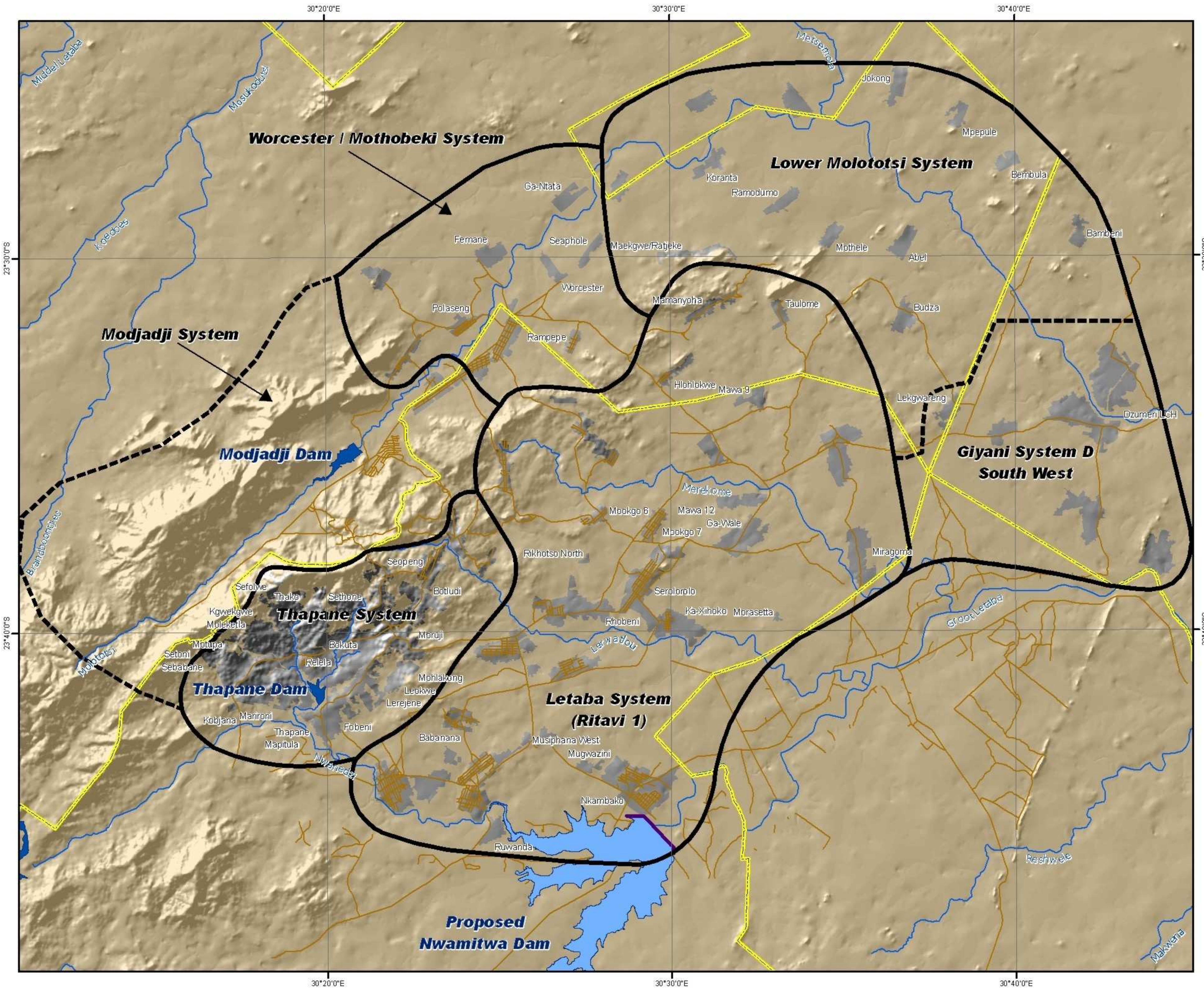
The Letaba system is bound by the Thapane system in the south-west, the lower Worcester/Molototsi system in the north and the Greater Giyani system in the east.

The Letaba system currently draws its water from a weir in the Great Letaba River. Raw water is pumped through a 300 mm diameter pipe to a raw water storage dam at Nkambako Water Treatment Works (WTW).

The system was first constructed in the period pre-1994, where after a significant number of upgrading and extension works have been undertaken to the system. The most recent of the extension works was the construction of a 5 Mℓ command reservoir at Serolorolo and a 315 mm diameter rising main from Nkambako WTW to Serolorolo command reservoir. The 5 Mℓ reservoir has, however, not been operational since construction due to inadequate upstream pipeline and pump station capacity.

The Letaba System is currently operated as outlined below:

- Raw water is treated at Nkambako WTW which has a capacity of 6 Mℓ/day.



Rivers
Secondary Roads
Proposed Dam Wall
Dams
Villages
Municipality Boundaries
Proposed Supply Areas of Nwamitwa Dam

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CONSULTANT: aurecon

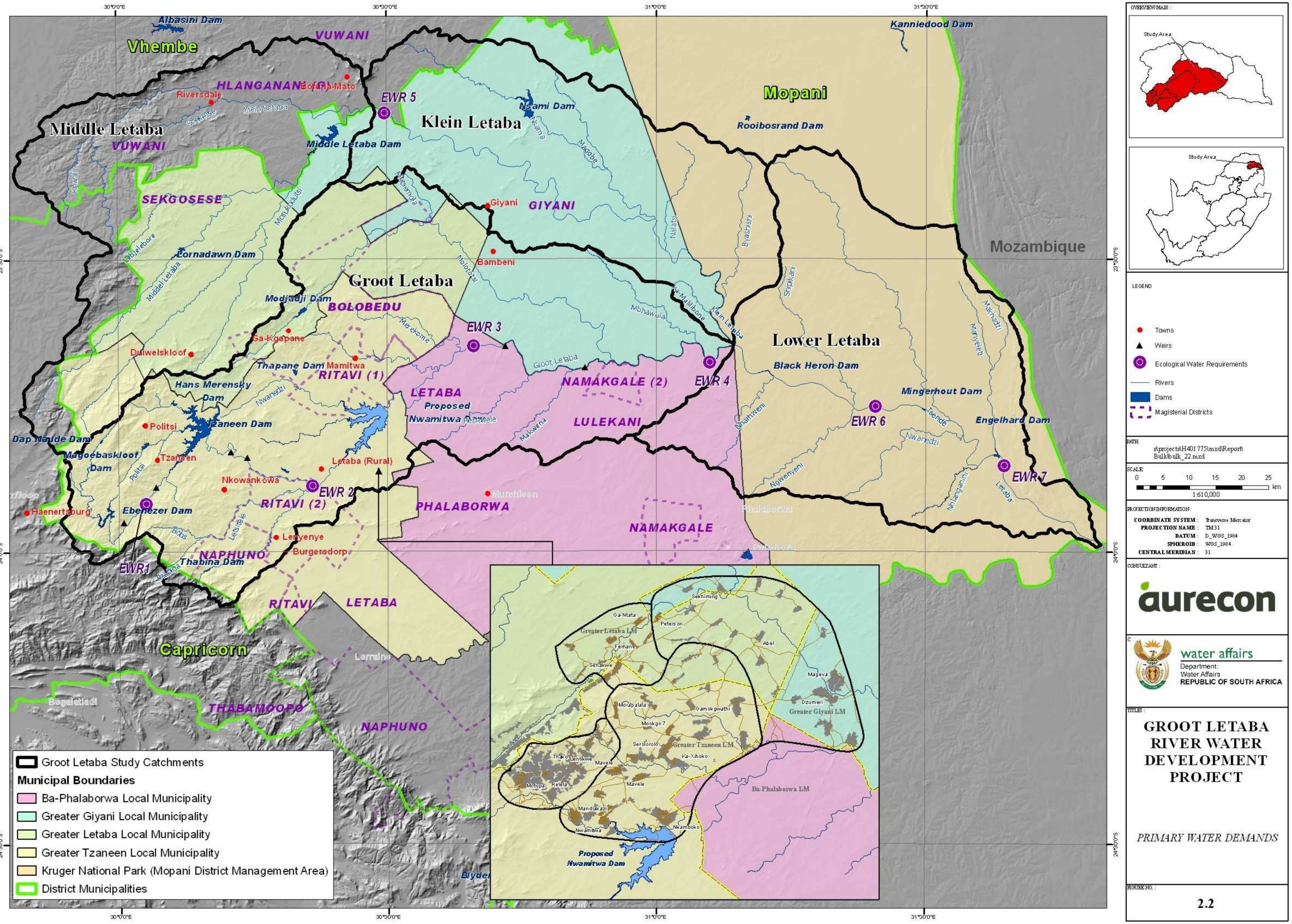
CLIENT: water affairs
Department: Water Affairs
REPUBLIC OF SOUTH AFRICA

TITLE:

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT

Supply Systems

FIGURE NO.: 2.1



OVERVIEW MAPS :
Study Area
Study Area
LEGEND
Towns
Weirs
Ecological Water Requirements
Rivers
Dams
Magisterial Districts
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TITLES :
GROOT LETABA RIVER WATER DEVELOPMENT PROJECT
PRIMARY WATER DEMANDS
FIGURE NO. :
2.2
Groot Letaba Study Catchments
Municipal Boundaries
Ba-Phalaborwa Local Municipality
Greater Giyani Local Municipality
Greater Letaba Local Municipality
Greater Tzaneen Local Municipality
Kruger National Park (Mopani District Management Area)
District Municipalities
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30°30'0"E
31°0'0"E
31°30'0"E
23°30'0"S
24°0'0"S
24°30'0"S
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Mopani
Capricorn
Mozambique
Middle Letaba
Klein Letaba
Groot Letaba
Lower Letaba
VUWANI
HLANGANANI
SEKGOSESE
GIYANI
BOLOBEDU
RITAVI (1)
RITAVI (2)
RITAVI
LETABA
NAMAKGALE (2)
NAMAKGALE
LULEKANI
PHALABORWA
NAPHUNO
THABAMOOPO
Albasini Dam
Kanniedood Dam
Nsami Dam
Middle Letaba Dam
Rooibosrand Dam
Lornadawn Dam
Modjadji Dam
Thapane Dam
Hans Merensky Dam
Tzaneen Dam
Dap Naude Dam
Magoebaskloof Dam
Ebenezer Dam
Thabina Dam
Black Heron Dam
Mingerhout Dam
Engelhard Dam
Proposed Nwamitwa Dam
EWR 1
EWR 2
EWR 3
EWR 4
EWR 5
EWR 6
EWR 7
Riversdale
Bochum-Mato
Giyani
Bambeni
Duiwelskloof
Ga-Kgapane
Mamitwa
Politsi
Tzaneen
Nkowankowa
Letaba (Rural)
Haenertsburg
Lenyenye
Burgersdorp
Murchison
Phalaborwa
Lorraine
Greater Letaba LM
Greater Giyani LM
Greater Tzaneen LM
Ba-Phalaborwa LM
Sekhiming
Ga-Ntata
Peterson
Femane
Abel
Senakwe
Mageva
Dzumeri
Motupalala
Gamokgwathi
Mookgo
Serolorolo
Ka-Xihoko
Thako
Lenbikwe
Mavele
Motupa
Relela
Mandlakazi
Nwamitwa
Nkambako

- Clear water is pumped to command reservoirs at Musiphana, Runnymede, Babanana and Serolorolo.

- Musiphana command reservoirs supply: Musiphana East, Musiphana West, Fofoza, Nwamitwa, Ruwanda, Mugwazini, Ka-Mswazi and Nkambako.

- Babanana command reservoir supplies Babanana, Lwandlamuni, Mbekwana and Mandlakazi.

- Runnymede command reservoir supplies Runnymede.

- The pipeline that supplies Serolorolo reservoir serves Jopi and Ka-Xihoko reservoirs as well.

- The pipeline to Runnymede command reservoir also serves Mavele service reservoir.

- There is a 350 mm diameter pipe which supplies Serolorolo command reservoir, but it is not yet commissioned.

Based on the discussion with the operators of this system, a number of problems were identified. These are listed below:

- Water rationing is currently being experienced in the area. To convey water to one particular command reservoir, the supplies to other command reservoirs have to be isolated. This results in villagers going for days without water. It is believed that the primary cause of this is incorrect pump-type selection and operation problems at the WTW.

- There are many illegal connections on the bulk mains causing a lot of inefficiencies in the supply system. This is mainly attributed to the desire by consumers to have uninterrupted supply.

- Currently there is no water in Mookgo 7, Ga-Wale, Mawa 12, Mawa 8, Mawa 9, Mawa 12, Gamokgwathi and Miragoma despite having supply pipelines. This is because the 5 Mℓ command reservoir at Serolorolo is currently not operational.

- Mookgo 6, Morapalala, Mabyepelong, Hlohlokwe. Mamanyoha and Taulome villages are not connected to the bulk supply network.

2.2.2 Thapane System

The Thapane system is bound by the Lower Modjadji system in the north and the Letaba/Ritavi system in the east. The system serves villages which are in relatively close proximity to each other with the exception of Madumane and Pfapfamela.

The scheme is currently under the jurisdiction of Greater Tzaneen Municipality. The scheme is supplied by Thapane Dam, which has a reported yield of 1.5 Mm^3/a. Raw water is pumped to Thapane WTW using two submersible pumps with a total capacity of 50 l/s. Thapane WTW has a capacity to supply 4 100 kℓ /d; this requires the raw water pumps to both run continuously.

Supply Direction 1

- The old clear water pump station consists of two KSB pumps type WKLn 80/3, where one is a standby. The pump delivers 34 l/s through a 200 mm diameter pipe to Marironi command reservoir with a storage capacity of 600 kℓ.
- Marironi command reservoir provides water directly to Mapitlula, Kubjana and Marironi villages.
- There is a 200 mm gravity main from Marironi command reservoir that supplies Mopye and Kgwekgwe booster pump stations. Currently either Mopye or Kgwekgwe booster pump station is supplied with water for a period of three days, with the supply to the other pump station being isolated for that period of time. Every three days the supply is switched to the other booster pump station.
- Mopye booster pump station consists of two pump sets of type WKLn 80/8 (one is a standby). The pump station feeds two service reservoirs; one at Motupa and the other at Mopye. The operation is such that they pump to one reservoir at a time. The reservoir at Mopye is supplied until it is half-filled and then the supply is switched to Motupa reservoir. This ensures that both reservoirs get a supply of water per day. When half-filled, it takes about six hours for the reservoir to empty.
- Kgwekgwe booster pump station consists of two pump sets of type WKLn 40/5, impeller diameter 172 mm, with a rating of Q = 3 ℓ/s and H = 187 m. The pump supplies a service reservoir at Kelekeshe schools in Moleketla. The service reservoir supplies Moleketla, Jokong and Thako.

Supply Direction 2

- The new pump station at the WTW consists of two pump sets of type WKLn 80/11 where one is a standby. The pump delivers 19 l/s through a 200 mm diameter to 1.5 Mℓ Mohlakong command reservoir.
- There is a 200 mm gravity main from Mohlakong command reservoir to Morutji booster pump station.
- Morutji booster pump station consists of two pumps of type WKLn 65/3, impeller diameter 175 mm, rating Q = 15 ℓ/s, H = 106 m. It pumps to a 1.0 Mℓ command reservoir at Morutsi Primary School.
- There is a package plant at Semarela. Treated water is pumped to a 200 kℓ reservoir using two pump sets of type WKLn 65/6, impeller diameter 192 mm. Water then gravitates to the 1.0 Mℓ reservoir at Morutsi Primary School, as well as supplying standpipes in the surrounding villages in Seopeng.
- The 1.0 Mℓ reservoir at Morutsi Primary School gravity feeds Leokwe, Moruji villages and a 167 kℓ reservoir in Mohlakong. This service reservoir in Mohlakong supplies Bokuta, Fobeni, Thapane, Lerejene and Relela villages.
- There is a 200 mm gravity main supplying Botludi booster pump station from the 1.0 Mℓ reservoir at Morutsi Primary School.
- Botludi booster pump station consists of two pumps of type WKLn 50/4, rating Q = 7.4 ℓ/s, H = 142 m. It pumps to Botludi and Madumane service reservoirs.

Problems

Based on the discussion with the operators of this system, a number of problems were identified. These are listed below:

- Villagers do not receive a continuous supply of water throughout the day. Some villages go for three days without running water. This is as a result of inadequate water resources and inadequate infrastructure.
- The clear water pumps at Semarela package plant cannot operate continuously as their output is limited by the capacity of the package plant. The operators have to wait for a number of hours for clear water tanks to fill up.

- Major parts of Relela and Jokong do not have water supply, primarily due to lack of infrastructure. Mothomeng experiences inadequate pressure.

- There are many illegal connections on the bulk lines causing inefficiencies.

- There is a shortage of reticulation infrastructure and stand pipes have been vandalised.

2.2.3 Worcester/Molototsi Scheme

Background

The Worcester/Molototsi system is under the jurisdiction of Mopani District Municipality. The villages in this system are widely spaced and not all of them are connected to the existing bulk water supply infrastructure. The primary source of water is the Modjadji Dam, however, this supply is insufficient and the Worcester/Molototsi system is supplemented by groundwater supplies.

Current Operation

The system currently operates as outlined below

- Water is pumped from Modjadji WTW to a 1.5 Mℓ regional reservoir in Senopelwa, and then gravitates to Senakwe. In Senakwe there is a 200 mm diameter branch line which supplies the Mothobeki system. Between Senakwe and a 1.0 Mℓ regional reservoir in Rampepe, there is a booster pump station.

- There are three boreholes which also feed the 1.0 Mℓ regional reservoir in Rampepe.

- Water gravitates from Rampepe to a 2.5 Mℓ regional reservoir in Maekgwe.

- The 2.5 Mℓ regional reservoir gravity feeds the Lower Molototsi sub-system, which consists of Ramodumo, Mothele, Abel, Budza and Mpepule.

Problems

Based on the discussion with the operators of this system, a number of problems were identified. These are listed below:

- Supply from Modjadji WTW to Worcester/Molototsi system is erratic as focus of supply is mainly to Lower Modjadji sub-sytem.

- Peterson, Ga-Ntata, Koranta, Botshabelo, Sekhiming, Jokong and Bembula are currently not linked to the bulk supply system and are supplied by boreholes.
- Water from the boreholes is of poor quality and there have been reported cases of calcium deposition in pipes causing blockages.

2.2.4 Giyani System

Background

The Greater Giyani system is situated to the east of the Letaba system. The scheme is fed from Giyani WTW which draws raw water from Middle Letaba and Nsami Dams, and from a weir near Zava on the Groot Letaba River.

Current Operation

Greater Giyani is fed by gravity from a 5.7 Mℓ regional reservoir at Kremertart, where a 400 mm diameter gravity main supplies up to a 600 Kℓ regional reservoir near Bembula. There is a 300 mm diameter pipe gravity feeding from this regional reservoir up to Mamphata south and then reduces to a 250 mm diameter pipe up to Mageva. After Mageva, a 200 mm diameter pipe gravity feeds up to another 600 Kℓ regional reservoir before Mphageni. There is a 250 mm diameter pipe from this regional reservoir which gravity feeds Mphageni and Zava. There is a package plant in Zava which has the capacity of producing 444 Kℓ /day, and this feeds the system from the bottom end.

Problems

Due to all the connections and high water requirements on the bulk reticulation supply line from Kremertart, the lower areas beyond Dzumeri do not receive any water reticulation from a water treatment plant. Most of the settlements downstream of Dzumeri are now relying on groundwater supply.

2.3 EXISTING WATER TREATMENT WORKS AT NKAMBAKO

2.3.1 Raw Water Source and Quality

Surface water is currently pumped from a weir on the Groot Letaba River, just downstream of the proposed Nwamitwa Dam. The raw water is treated at the Nkambako Water Treatment Works (WTW).

The water quality characteristics, as obtained from DWA records for station B8H009Q01, are given in **Table 2.1**.

Table 2.1 Raw water quality

Parameter	Units	Minimum	Median	Maximum	Trend/comment
pH		6,5	6,9	7,5	No seasonal pattern, slight increase with time
Turbidity	NTU	16	30	200	Data obtained from plant records.
TDS	mg/l	40	67	500	No seasonal or time trend
Nitrate and nitrite	mgN/l	0	0,22	1,5	No trend
NH_4	mg/l	0	0,04	0,12	Increase over time, no seasonal trend
PO_4	mgP/l	0	0,009	0,2	No trend
F	mg/l		0,1	2	No trend
Cl	mg/l	1	10	50	No trend
SO_4^{--}	mg/l	0,2	10	18	No trend
Na	mg/l		7		No time trend. High concentrations in winter.

2.3.2 Required Treated Water Quality

The South African Bureau of Standards (SABS) sets out recommendations with respect to potable water in SANS 241-2006. The recommended standards for a Class I and Class II water are given in **Table 2.2**.

Table 2.2 SANS 241 – 2006 water quality

Parameter	Units	Class I	Class II	Available data	Class II Consumption period
pH		5 to 9,5	4 to 10	7,5	No health effect
Turbidity	NTU	0,1 to 1	> 1 to 10	200	Risk of pathogen contamination
TDS	mg/l	450 to 1000	>1000 to 2400	500	7 years
NH_4	mg/l	0,2 to 1	>1,0 to 2		Risk of pathogen contamination
Cl^-	mg/l	100 to 200	>200 to 600		7 years
F^-	mg/l	100 to 200	>200 to 600		7 years
Nitrate & nitrite	mgN/l	6 to 10	>10 to 20		7 years
SO_4^{--}	mg/l	200 to 400	>400 to 600		7 years
F^-	mg/l	0,7 to 1	>1 to 1,5		I year
Mg	mg/l	30 to 70	>70 to 100		7 years
Zn	mg/l	3 to 5	>5 to 10		1 year
DOC	mg/l	5 to 10	>10 to 20		3 months
THM	µg/l	100 to 200	>200 to 300		10 years

The treated water quality should comply with Class I requirements.

A comparison of the available data on water quality and the SANS Class II requirements reveals that the primary function of the treatment works is the removal of turbidity and disinfection of the treated water.

2.3.3 Description and Performance of the Existing Treatment Works

Raw water is withdrawn from the Groot Letaba River and pumped to a raw water storage reservoir. From there it flows under gravity into the treatment works.

The works comprises a single module with a capacity of 6 Mℓ/d. An identical second module is under construction, but has not yet been commissioned. After completion of the second module the plant will have a total capacity of 12 Mℓ/d.

The plant configuration and loading parameters are as follows:

1) Chemical dosing

Coagulant chemicals and lime for pH adjustment are dosed into the inlet channel at a point of turbulence.

2) Flocculation

Flocculation occurs in an hydraulically mixed flocculation channel having the following characteristics:

(i)	Retention	:	26 minutes at design flow
(ii)	Flocculation shear	:	Stepped 23 to 7 s^{-1}
(iii)	Primary particle reduction	:	98%

3) Sedimentation (2 No tanks per module)

(i)	Surface loading	:	0,9 $m^3/m^2/h$
(ii)	Retention time	:	3,2 hours

4) Filters (3 No per module):

(i)	Surface loading	:	6,7 $m^3/m^2/h$

During an inspection of the works the following shortcomings were noted:

- Insufficient mixing of the chemicals into the raw water.
- Only a single sludge withdrawal pipe was provided for each of the sedimentation tanks resulting in inadequate sludge removal. Retention time is short.
- Backwash pumps had been removed for repair.

Perusal of the plant records showed that treated water quality failed to meet SANS Class I requirements (the South African Bureau of Standards (SABS) sets out recommendations with respect to potable water in SANS 241-2006) and was generally within the Class II requirements.

With improved rapid mix of chemicals into the raw water, adequate sludge removal and repair of the filter backwash plant, the treatment works should be capable of producing a treated water in compliance with Class I requirements.

2.4 EXISTING GROUNDWATER USE

A desktop study (based on the information in the GRIP database) was undertaken to ascertain the present use of groundwater in the study area as well as potential supply from groundwater. The census of groundwater infrastructure indicates that many of the regions which are not connected to the existing bulk water supply network, have access to enough groundwater to satisfy the current basic survival demand of 16 litres/capita/day. The Thapane system and most of the Letaba system has access to bulk supplies from surface sources, augmented from groundwater.

Table 2.3 shows the extent of the current groundwater use in each supply region. It must be noted, however, that despite the existing groundwater yield exceeding the total survival requirements, this does not necessarily mean that there is enough water to meet this demand in every village. High yielding boreholes are not homogeneously distributed throughout the study area and are not always located close to villages with a high demand.

Table 2.3 Existing groundwater resources in the supply area

Village Region	2007 Demand (kℓ/d aadd)			Existing Groundwater Yield (kℓ/d)	Overall Borehole Water Quality Class
	Survival (16 ℓ/c/d)	Standard (25 ℓ/c/d)	High (35 ℓ/c/d)		
Letaba / Ritavi System	4 297	7 462	10 158	3 341	Class II
Thapane System	2 467	4 366	5 933	689	Class I
Lower Molototsi and Worcester/Mothobeki System	1 741	2 814	3 846	4 047	Class III
Giyani System	1 349	2 500	3 395	3 254	Class III
TOTAL	**9 854**	**17 142**	**23 332**	**11 330**	

Another important consideration is that of borehole water quality. The DWAF water quality guidelines were used as a basis for determining the water quality requirements for different users. The classifications for domestic use are divided into five classes and are given in **Table 2.4**.

Table 2.4 DWAF domestic water quality classes

DWAF Classification	Description	Percentage of Study Area
Class 0	Water of an ideal quality	21
Class I	A good quality water	15
Class II	Water which is safe for short term use	38
Class III	An unacceptable quality of water	18
Class IV	Poor quality water	8

Most of the good quality groundwater is found in the relatively wetter western part of the study area. The north-eastern part of the region, namely the villages in the Worcester/Molototsi system rely on boreholes yielding Class III and IV water, which is unsuitable for potable use. Elevated concentrations of calcium and magnesium are in most cases responsible for the poor water quality. There are also boreholes which are sited in the villages and are consequently being contaminated with nitrates from nearby pit latrines. These nitrate contaminated boreholes can be rehabilitated with a sanitary seal, but the elevated levels of calcium and magnesium (caused by geological structures) will need ongoing treatment.

The boreholes situated outside the villages have dedicated pipelines supplying central storage tanks. These boreholes were installed to target geological shear or fault zones and, as such, are more reliable, both in terms of yield and water quality.

3. INFRASTRUCTURE NEEDS

3.1 WATER REQUIREMENTS

The future water requirements for all the settlements in the Study Area were supplied to the Study Team by EVN Africa. EVN Africa were appointed by the DWA (study entitled: Nwamitwa RWS: LPR 006) to assess the water requirements of the area taking into account inter alia service levels, socio economic development, water losses and the type of development. The estimated water requirements were derived from the population data within each settlement and a water requirement in litres/capita/day related to the level of service delivered. Three service levels were considered, namely basic (35 l/c/d), standard (120 l/c/d) and high (200 l/c/d). Information on the population projections and future water requirement projections per settlement per service level is given in **Appendix A** of this Report. A summary of the anticipated water requirements for the Study area is given in **Table 3.1**. The total water requirement from the proposed Nwamitwa Dam is estimated to be 11.2 Mm^3/a in 2027 when a higher level of service should be provided.

Table 3.1 Future water requirements in the study area

	Water Requirements for different Service Levels (Mm^3/a)								
	Survival			Standard			Higher		
	2007	2012	2027	2007	2012	2027	2007	2012	2027
Letaba Ritavi	1.6	1.8	2.1	2.7	3.2	3.9	3.7	4.3	5.2
Thapane	0.9	1.0	1.3	1.6	1.9	2.4	2.1	2.6	3.3
Less Thapane Source	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Thapane *				0.1	0.4	0.9	0.6	1.1	1.8
Worcester +Lower Molototsi	0.6	0.7	0.8	1.1	1.2	1.4	1.5	1.6	1.9
Greater Giyani	0.5	0.6	0.9	0.9	1.0	1.7	1.2	1.4	2.3
TOTAL	**2.7**	**3.0**	**3.7**	**4.7**	**5.8**	**7.9**	**7.0**	**8.4**	**11.2**

Note : Excludes the 1.5 Mm^3/a demand already supplied from Thapane Dam

Table 3.2 below shows the expected shortfall in the Modjadji system.

Table 3.2 Supply to the Modjadji System

	Water Requirements for different Service Levels (Mm3/a)								
	Survival			Standard			Higher		
	2007	2012	2027	2007	2012	2027	2007	2012	2027
Modjadji water requirements	1.4	1.7	2.4	2.6	3.2	4.8	3.5	4.3	6.4
Supply available from Modjadji Dam	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Modjadji shortfall	--	--	--	--	--	0.5	--	--	**2.1**

The total requirement from the proposed Nwamita Dam could be increased to by 2.1 million m^3/a to 13.3 Mm^3/a if the potential shortfall in the Mojadji system were to be supplied from Nwamitwa Dam in 2027.

3.2 LOGICAL SUPPLY AREA

In order to determine the logical area for the proposed Nwamitwa Dam the water requirements in the areas immediately surrounding the proposed dam were analysed and then compared to the anticipated yield from the proposed Nwamitwa Dam. The Water Resource Analysis (DWA, 2010a) indicates that 13 Mm^3/a could safely be supplied from Nwamitwa Dam at a 98% level of assurance for domestic use. The anticipated 2027 water requirement for the Letaba/Ritavi, Thapane and Worcester/Molototsi (including part of Giyani) supply areas is 11.2 Mm^3/a. This can be supplied from the yield of 13 Mm^3/a which was determined for a dam with a Full Supply Level of 479.5 masl.

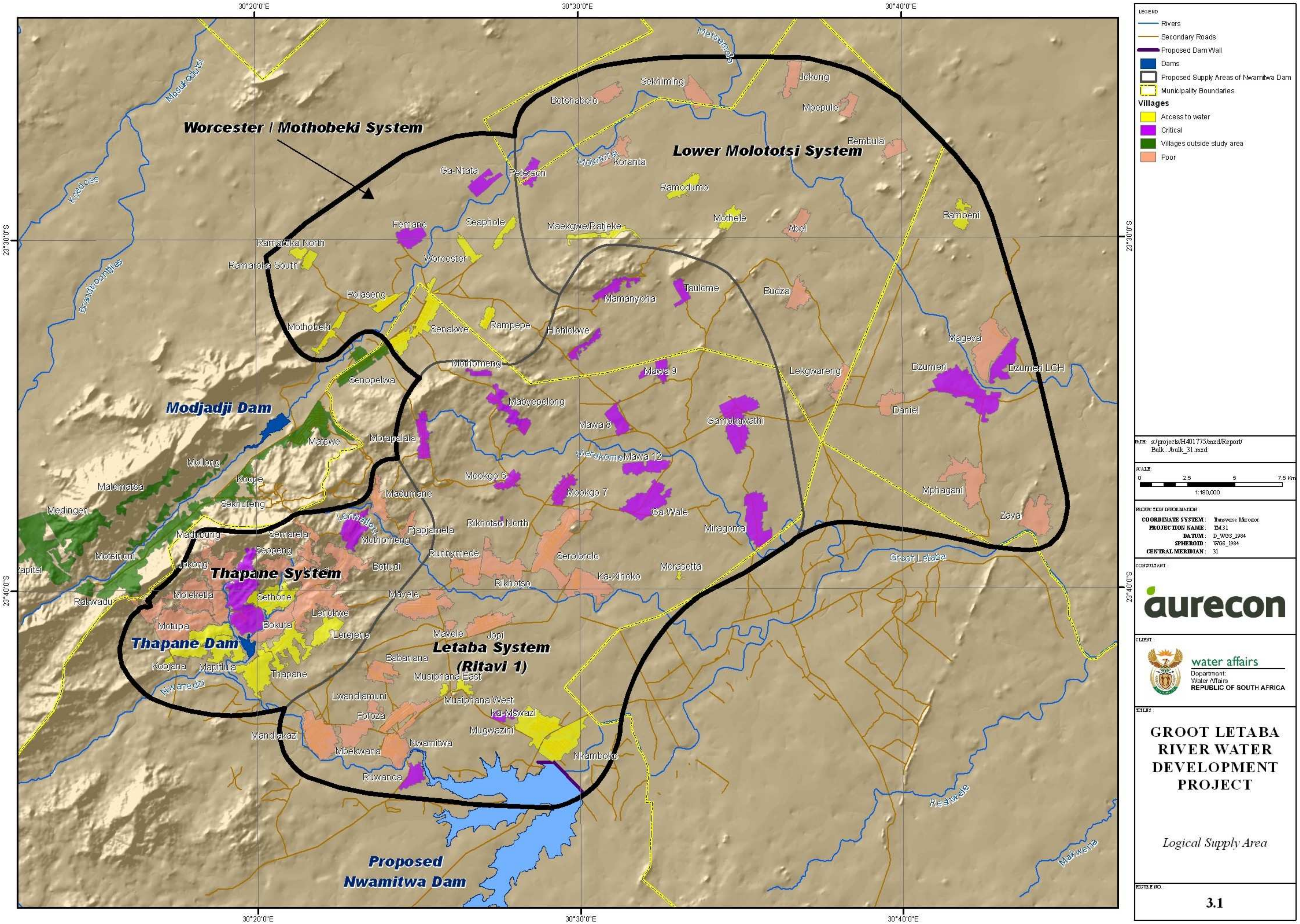
The Modjadji Sub system currently supplies the Worcester/Molototsi system with water. It is proposed that the current supply area for the Modjadji system be reduced to serve only the area in the vicinity of Modjadji Dam and not the Worcester/Molototsi system as well. This approach will make the Modjadji system self reliant (on the Modjadji Dam), with a potential shortfall to the Modjadji system only occurring under the high water requirement service level beyond 2012. The shortfall in the Mojadji system excludes the existing groundwater source and any future groundwater availability. As the Modjadji system has a high groundwater potential it is recommended that this resource be investigated prior to investing in expensive infrastructure to convey water from the proposed Nwamitwa Dam to the Modjadji area.

It would also be uneconomical to lay bulk infrastructure from the proposed Nwamitwa Dam to meet the peak week water requirement in the Modjadji system. The existing capacity in the regional bulk infrastructure to the Worcester/Molototsi system which is designed to meet the peak week water requirements for the area could also be used to supply additional water to the Modjadji system during off peak periods and additional storage capacity could be built in the Modjadji system to meet the peak week water requirement. Providing additional potable water storage in the Modjadji area would also increase the security of supply in the Modjadji area in case of a disruption of supply from the proposed Nwamitwa Dam.

It is proposed that the bulk water supply to the Worcester/Molototsi System be used to supplement the shortfall to the Modjadji system, if it is required, prior to the full high water requirement being utilised in the Worcester/Molototsi system.

The villages of Daniel, Dzumeri, Nogeva, Mphagani and Zava which should be supplied by the Giyani sub-system are included in the logical supply area, as these villages currently receive no potable water because of infrastructure capacity constraints and inadequate supplies. These villages currently rely solely upon groundwater.

Figure 3.1 shows the logical supply area to be served from Nwamitwa Dam and the current water availability in each settlement. The settlements identified as “water critical” have limited or poor groundwater supply and either no bulk water supply infrastructure or bulk water supply infrastructure which is not used. The settlements identified as “water poor” have limited or poor groundwater supply and limited or rationed access to potable water.


30°20'0"E
30°30'0"E
30°40'0"E
23°30'0"S
23°40'0"S
Worcester / Mothobeki System
Lower Molototsi System
Thapane System
Letaba System (Ritavi 1)
Modjadji Dam
Thapane Dam
Proposed Nwamitwa Dam
Sekhiming
Jokong
Botshabelo
Mpepule
Bembula
Koranta
Ga-Ntata
Peterson
Ramodumo
Mothele
Abel
Bambeni
Femane
Seaphole
Maekgwe/Ratjeke
Ramaroka North
Ramaroka South
Worcester
Polaseng
Taulome
Budza
Mamanyoha
Mothobeki
Senakwe
Rampepe
Hlohlokwe
Mageva
Dzumeri
Dzumeri LCH
Mothomeng
Mawa 9
Lekgwareng
Senopelwa
Mabyepelong
Gamokgwathi
Daniel
Matswe
Morapalala
Mawa 8
Mawa 12
Molong
Malematsa
Kgoge
Mookgo 6
Mookgo 7
Mphagani
Medingen
Sekhuteng
Madumane
Ga-Wale
Zava
Lenyenye
Mothomeng
Pjapjamela
Rikhotso North
Miragoma
Madubung
Semarela
Motsinoni
Seopeng
Runnymede
Serolorolo
Morasetta
Botludi
Ka-Xihoko
Rikhotso
Rakwadu
Moleketla
Sethone
Mavele
Lenokwe
Motupa
Bokuta
Lerejene
Mavele
Jopi
Babanana
Kobjana
Mapitlula
Thapane
Musiphana East
Lwandlamuni
Musiphana West
Fofoza
Ka-Mswazi
Mandlakazi
Mugwazini
Mbekwana
Nwamitwa
Nkamboko
Ruwanda
Mosukodutsi
Koedoes
Brandboontjies
Metsemola
Molototsi
Merekome
Groot Letaba
Nwanedzi
Reenwele
Makwena
LEGEND
Rivers
Secondary Roads
Proposed Dam Wall
Dams
Proposed Supply Areas of Nwamitwa Dam
Municipality Boundaries
Villages
Access to water
Critical
Villages outside study area
Poor
s:/projects/H401775/mxd/Report/Bulk.../bulk_31.mxd
SCALE
0 2.5 5 7.5 Km
1:180,000
PROJECTION INFORMATION :
COORDINATE SYSTEM : Transverse Mercator
PROJECTION NAME : TM31
DATUM : D_WGS_1984
SPHEROID : WGS_1984
CENTRAL MERIDIAN : 31
CONSULTANT :
aurecon
CLIENT :
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA
TITLE :
GROOT LETABA RIVER WATER DEVELOPMENT PROJECT
Logical Supply Area
FIGURE NO. :
3.1

4. INFRASTRUCTURE MASTER PLAN

4.1 REGIONAL BULK INFRASTRUCTURE

Once the logical supply area were defined, the next step was to determine where to site the Regional Bulk Water Command Reservoirs, which areas the command reservoirs should serve and what the capacity of the command reservoirs should be. The following criteria were used in determining where to site the proposed command reservoirs:

- The command reservoirs should be at an elevation high enough to feed the supply area under gravity.
- The command reservoirs should be situated in order to facilitate maximum system flexibility, provide redundancy and be able to serve more than one system in the case of emergency.
- The command reservoirs should be able to integrate with any proposed future groundwater supply schemes.
- The siting of the command reservoirs should be able to provide flexibility in order to enable future expansion of the supply area if required.

4.1.1 Command Reservoirs

Currently all the supply systems include a number of village reservoirs as well as a few main regional reservoirs. The purpose of the regional reservoirs (or command reservoirs) is to provide balancing storage as well as emergency storage in the case of a disruption to supply.

It is proposed to provide bulk command reservoirs in the Worcester/Molototsi system (including a service to parts of the Giyani system), Thapane and Letaba/Ritavi systems by constructing two new command reservoirs (command reservoir C and D). Two existing regional supply reservoirs, namely the 5 Mℓ reservoir at Serolorolo (command reservoir A) and the 7 Mℓ reservoir at Babanana (command Reservoir B) should be utilised as command reservoirs. One new command reservoir (command Reservoir C) will be located on a ridge to the north-west of the Letaba/Ritavi system to supply the Worcester/Molototsi system. The location of this reservoir will also enable backfeed into the Letaba/Ritavi system in case of emergency. The second command reservoir (command Reservoir D) will be located on a hill north-east of Gamokgwathi to supply the Giyani villages. The location of this reservoir will also enable backfeed into the Letaba/Ritavi system in case of emergency. These two proposed command reservoirs would be fed from the existing 5 Mℓ Serolorolo command reservoir (command Reservoir A), which also supplies the Letaba system. The 7 Mℓ reservoir at Babanana (command reservoir B), which also supplies the villages near Babanana and Musiphana, will be utilised to transfer water from the Letaba system through to the Thapane system.

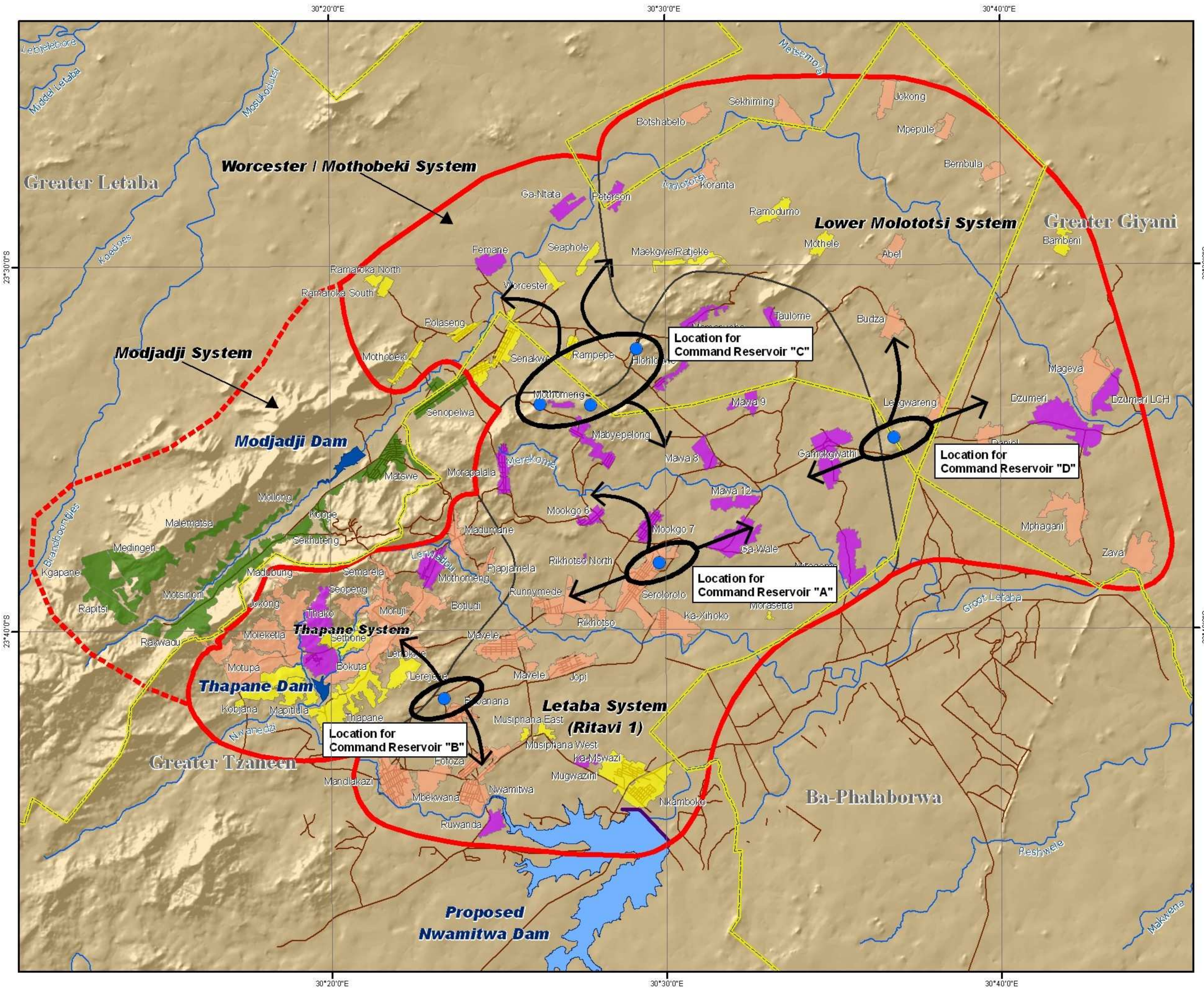
There are two existing reservoirs at Serolorolo, a 600 Kℓ reservoir and a 5 Mℓ reservoir (command Rservoir A).

The proposed two new command reservoirs are situated at an elevation high enough to feed the supply area under gravity. For this reason the command reservoirs are capable of supplying villages outside their respective supply areas, which adds redundancy, and also reliability, to the system. **Figure 4.1** shows the proposed location of the command reservoirs as well as the possible supply directions of the proposed command reservoirs. The relief in **Figure 4.1** has been exaggerated to illustrate the reasoning behind the siting of the reservoirs in terms of elevation and location.

Appendix B shows the proposed supply zones of the command reservoirs as well as existing bulk water supply reservoirs, and also the anticipated water requirements in each supply zone.

4.1.2 Pipelines and pump stations

Existing pipelines from Nkambako WTW were designed to cater for the Letaba system only. Linking of the three systems will require the installation of additional bulk water pipeline capacity and the upgrading of clear water pumps. It is proposed that two new bulk pipelines be constructed, one from Nkambako WTW to the existing Babanana command reservoir (command reservoir B) and the other from Nkambako WTW to the existing Serolorolo command reservoir (command reservoir A). A pipeline with a booster pump station is proposed to link Babanana command reservoir and the proposed Mohlakong regional reservoir in Thapane. The existing 300 mm diameter pumping main from the Nkambako WTW will be dedicated to supply the regional reservoir at Runnymede. There is concern that the pipe material chosen for certain sections of the 350 mm diameter pipeline, recently constructed between the Nkambako WTW and the 5 Mℓ reservoir at Serolorolo, is incorrect for the current application. This aspect is discussed in more detail in **Section 6** of this Report.



LEGEND

- New Reservoirs
- Rivers
- Secondary Roads
- Proposed Dam Wall
- Proposed Nwamitwa Dam
- Proposed Supply Areas of Nwamitwa Dam
- Municipality Boundaries
- Modjadji Sub-scheme
- Logical Supply Area

Villages

- Access to water
- Critical
- Villages outside study area
- Poor

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1:185,000

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DATUM:	D_WGS_1984
SPHEROID:	WGS_1984
CENTRAL MERIDIAN:	31

CONSULTANT:

aurecon

CLIENT:

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

TITLE:

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT

Locations for Common Reservoirs

FIGURE NO.

4.1

The Worcester/Molototsi system (including parts of the Giyani supply area) has to be linked by new pipelines from Serolorolo command reservoir to the proposed command reservoirs, C and D. These reservoirs will then feed into Worcester/Molototsi through the Worcester/Mothobeki and the Giyani systems.

The existing clear water pumps at Nkambako WTW cannot supply the combined system and it is therefore proposed that new pumping capacity be provided to serve the Babanana command reservoir and another for the Serolorolo command reservoir, and that the existing pumps be used to serve the Runnymede regional reservoir. Mohlakong regional reservoir is at an elevation of 72 m above Babanana command reservoir and a booster pump station will therefore be required to pump the water destined for the Thapane system to the proposed new regional reservoir at Mohlakong. There is also a need for a rising main with pump station to supply the proposed command reservoir C north-west of the village of Hlohlokwe from the command reservoir at Serolorolo. Command Reservoir D, situated to the north-east of Gamokgwathi, can be fed by the bulk water gravity main from the existing command reservoir at Serolorolo.

4.1.3 Water Treatment Works

In order to satisfy the anticipated growth in future peak week water requirements, the Nkambako WTW will ultimately have to be expanded to a capacity of approximately 45 Mℓ/d. This will enable the WTW to meet the peak week water demand in 2027 (i.e. 1.5* (2027) AADD kℓ/d). **Figure 4.2** shows the anticipated growth in peak week demand (PWD) from 2007 through to 2027.

Figure 4.2 illustrates the theoretical peak week water requirement should all the regional and connector bulk water supply infrastructure as well as the reticulation infrastructure be implemented and fully operational for the basic, standard and high level of service. A WTW capacity in increments of 12 Mℓ/d is shown on the Y axis.

It is important for Mopani District Municipality to meter and monitor the actual water usage to enable them to plan for the timely expansion of the Nkambako WTW in a modular fashion.

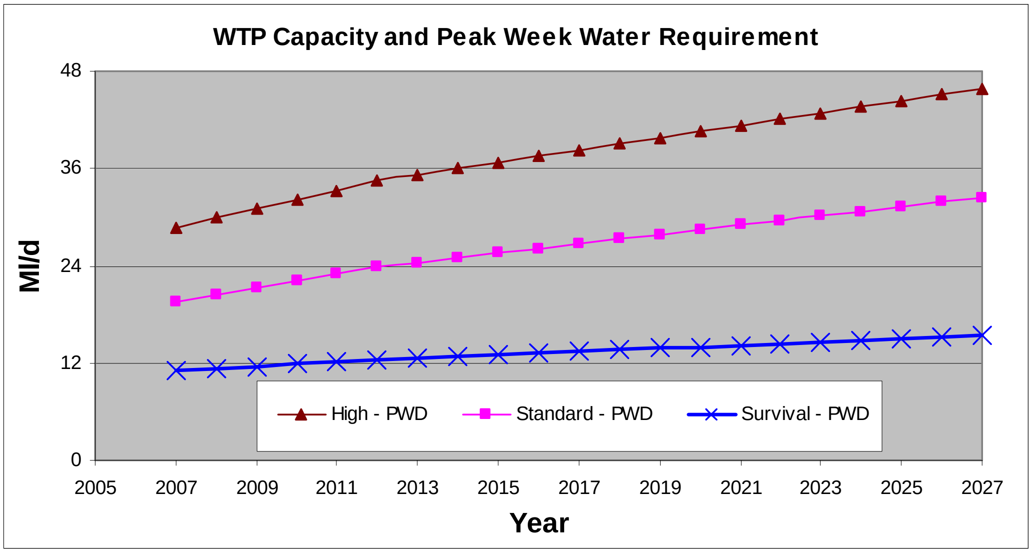


Figure 4.2 Water Treatment Works capacity and peak week water requirement

4.2 GROUNDWATER USE

As outlined in **Section 2.4**,

A large number of villages in the region are being supplied by groundwater to meet their daily needs. Many of the boreholes, however, deliver water of poor quality and as such, require treatment before use. Blending poor borehole water with treated surface water to dilute the high concentrations of solutes is one method of utilising the existing groundwater supply which was investigated.

The following groundwater use scenarios were investigated:

- Utilisation of existing groundwater supply by means of blending
- Utilisation of all existing groundwater supply by means of treatment
- Utilisation of all Class 1 existing groundwater supply
- Utilisation of future groundwater supply by means of blending
- Full groundwater utilisation

In terms of the methodology that was followed, each village was analysed as a separate entity. The GRIPP database allowed each village's current borehole yield, together with the quality of this water, to be determined. Using this information, it was possible to calculate how much potable water treated at Nkambako WTW would be required to blend any poor quality water to an acceptable potable standard, using the blending ratios as described in the next section.

Should the amount of water required from the Nkambako WTW for blending exceed the current or future demand, it was further calculated what percentage of the poor quality groundwater (together with the blending water) could be used in order to satisfy the demand. If the resultant groundwater and blend-water volume was insufficient to supply the entire demand, the shortfall was met from the Dam.

The following assumptions were made in the analysis:

- If a borehole was contaminated by pit latrines (i.e. nitrates were present in the water sample) it was completely excluded from this analysis.
- Only treated water from the WTW was used as blending water. In other words, if clean, good quality groundwater was available, it was not used to blend with other poor quality groundwater.

4.2.1 Water Quality

The boreholes used in the study area were chemically analysed and each borehole was assigned a quality class. It was found that most of the borehole water being used is of good quality, and that there are also a high percentage of boreholes that can be used on a short-term basis. Groundwater of unacceptable quality amounts to 26%. Most of these boreholes are located in the eastern part of the study area, furthest from the proposed Nwamitwa Dam and its WTW. Due to the fact that the constituents of the groundwater are of a soluble nature and that potable water is available, blending can be used to "treat" poor quality water. This basically involves the blending of poor quality water with good quality water at defined ratios such that the concentrations of the resulting volume place it in a Domestic Water Quality Class 0 or Class I. The DWAF Domestic Water Quality Classes are in part defined by the concentrations given in **Table 4.1**. This by no means an exhaustive list, but it does define the main water quality problems in this region.

Table 4.1 DWAF Domestic Water Quality Classes

Class	pH	Chlorine (Cl)	Total Dissolved Solids (TDS)	Conductivity (EC)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
Class 0	6-9	0-100	0-450	0-70	0-10	0-30	0-100
Class I	5-6 / 9-9.5	100-200	450-1000	70-150	10-32	30-70	100-200
Class II	4-5 / 9.5-10	200-600	1000-2000	150-370	32-80	70-100	200-400
Class III	<4 / >10	>600	>2000	>370	>80	>100	>400

Using the above concentration parameters, it was determined what volume of clean treated water (Class 0) would be required per volume of poor quality water for each quality class, in order to obtain a resultant Class I:

- Water in Class II can form up to 25% of the final volume
- Water in Class III can form up to 15% of the final volume
- Water in Class IV can form up to 8% of the final volume

It must be noted however, that in order for the groundwater to be blended with treated water, poor quality groundwater must be collected in a central village storage tank and subsequently mixed with treated water in a village storage reservoir before it is supplied to users.

5. COMMAND RESERVOIRS

5.1 DESIGN CRITERIA

The analysis of the existing networks was done with reference to the DWAF guidelines entitled *Technical guidelines for planning and design in the development of water and sanitation services (DWAF,* 2004). The DWAF technical guidelines were also checked against the recommendations made in the definitive publication on urban planning and infrastructure standards, *Guidelines for human settlement planning and design* (Department of Housing, 2000).

Table 5.1 shows the general summary of the design criteria used in the analysis.

Table 5.1 Summary of design criteria

1.0	Peak factors	Summer peak factor (SPF) = 1.5
2.0	Design flow (bulk supply pipelines)	Summer daily demand (SDD) = SPF * AADD
3.0	Design peak factor (for reticulation)	3
4.0	Velocities	2.5 m/s for gravity mains and 2.0 m/s for pumping mains
5.0	Storage reservoirs (sizing)	48hrs * AADD (pumped from one source) 36hrs * AADD (pumped from two sources) 24hrs * AADD (gravity source)

5.2 COMMAND RESERVOIRS

In determining the size of a reservoir the following factors must be taken into consideration:

1) Reservoirs must allow for short-term balancing capacity to cater for the difference in the demands from the reservoir and the supply into the reservoir. Correctly sizing village reservoirs will reduce the capital expenditure required in upstream infrastructure (pipelines and pump stations), as the reservoirs will provide the balancing storage required during peak day demands as opposed to the peak day demands being conveyed by the bulk infrastructure supplying the reservoirs.

2) Reservoirs must have sufficient storage capacity in order to be able to supply downstream consumers in the event of disruptions to the bulk water supply to the reservoirs.

An analysis was undertaken to determine the available storage in hours, based on the standard and high water requirement for 2007 and 2027. It is proposed that the two new command reservoirs C and D be sized at 5 Mℓ. This would ensure compliance with the requirement to provide approximately 48 hours of storage in the reticulation system in the case of a pumped supply with one source and approximately 36 hours of storage in the reticulation system in the case of a pumped supply with two sources. This capacity is also comparable to the existing 5 Mℓ Reservoir at Serolorolo and the existing 7 Mℓ Reservoir at Babanana. The available storage, in terms of hours of supply, for the area of supply is shown in **Appendix C** of this Report.

A further motivation for this sizing was based on the following considerations:

- To prevent the bulk connector infrastructure from draining during a peak week water demand should there be disruptions to the bulk water supply during this period
- To assist with pump operation
- To provide emergency storage at the end of a two rising mains

The geographical location of the proposed Command Reservoirs on a 1:10 000 background, as well as the proposed preliminary layout drawings of a 5 Mℓ command reservoir is shown in **Appendix D** of this Report.

6. PIPELINES AND PUMP STATIONS

6.1 DESIGN CRITERIA AND METHODOLOGY

This section deals with the preliminary optimisation of the treated water pipelines and pump stations that would supply treated water to the various command reservoirs within the bulk supply system.

6.1.1 Identification of potential pipeline routes

Various pipeline routes to each of the command reservoirs were identified and evaluated to determine the most economical options, taking factors such as capital costs (mainly a function of pipeline length), operating costs (influenced by pumping head and pipe friction), maintenance costs, and operational aspects (e.g. access to pipeline route) into account.

A description of the identified alternative pipeline routes to and from each Command Reservoir is described in **Section 6.3** of this Report.

6.1.2 Water demands

The average annual daily demands (AADD) and peak week water demands for the 2008 and 2027 scenarios are shown in **Table 6.1** for each of the command reservoirs, as well as for the Musiphana Reservoirs and the Runnymede Reservoirs.

Peak week factors of 1,5 and 2,0 were applied to the AADD for the bulk water rising and gravity mains, respectively. The peak week factor of 1,5 used for the rising mains includes provision for pumping 20 hours per day.

Appendix B contains a graphical illustration of the extent of the supply zones for each bulk water supply reservoir.

Table 6.1 Demands at reservoirs

Reservoir	Demand scenario	AADD (kℓ/d)	AADD (ℓ/s)	Peak week factor	Peak week demand (ℓ/s)
Command Reservoir A	2008	11 466	133	1,5	199
	2027	16 889	195	1,5	293

Reservoir	Demand scenario	AADD (kℓ/d)	AADD (ℓ/s)	Peak week factor	Peak week demand (ℓ/s)
Command Reservoir B	2008	5 154	60	1,5	90
	2027	9 914	115	1,5	172
Command Reservoir C	2008	4 454	52	1,5	77
	2027	5 675	66	1,5	99
Command Reservoir C (alternative)	2008	4 189	48	1,5	73
	2027	5 327	62	1,5	92
Command Reservoir D	2008	3 247	38	2,0	75
	2027	6 299	73	2,0	146
Musiphana Reservoir	2008	1 166	13	1,5	20
	2027	1 625	19	1,5	28
Runnymede Reservoir	2008	1 547	18	1,5	27
	2027	2 132	25	1,5	37

6.1.3 Criteria for optimisation of pumping schemes

Pumping systems were optimised on the basis of the present value of capital, operating and maintenance costs for each pipeline for different pipeline diameters for the 2027 demand scenarios.

A preferred pipeline route was selected to each of the command reservoirs, based on the optimisation for the 2027 demand scenario. The optimisation process was then repeated for the 2008 demand scenario to determine the optimum pipeline diameter required in the short-term. This was used as a basis for evaluating the possibility of phasing the construction of infrastructure.

The net present value calculations were based on the following parameters:

- Discount period = 25 years
- Discount rate = 6%
- Electricity cost = 25 c/kWh (including voltage and transmission costs)
- Mechanical and electrical maintenance costs = 4% per annum of mechanical and electrical costs

- Civil maintenance costs = 0,5% per annum of civil costs

The construction cost estimates were based on recent tendered rates for projects similar in size and nature.

The choice of pipe material, the impact of waterhammer pressures, etc. are discussed in more detail in **Section 6.3**.

6.1.4 Criteria for pump selection

The cost functions applied for calculating the capital cost of the pumps and associated mechanical and electrical equipment were based on using multi-stage centrifugal pumps. **Section 6.4** expands on the pump selection and preliminary pump station layouts based on the pump duties determined for the optimum rising main sizes.

6.2 UTILISATION OF EXISTING INFRASTRUCTURE

The clear water pump station at the existing WTW comprises three KSB WKLn 80/4 pumps, fitted with 220 mm impellers. The motor sizes are 110 kW, operating at 2 900 rpm. Two of the pumpsets were installed in January 2005 and are still in good working condition. It should further be noted that the space inside the clear well pump station is limited and it would therefore be unlikely that larger pumps could be installed in the existing space.

The existing rising main from the WTW is a 300 mm diameter pipeline to a point downstream of the Musiphana Reservoirs, where it changes to a 200 mm diameter pipeline to the Runnymede Reservoirs.

Based on the good working condition of the existing pumps, it would be preferable to utilise the existing infrastructure as far as possible.

The pumping capacity of the existing pumps is reported to be approximately 70 ℓ/s with two pumps operating in parallel. This corresponds roughly with the combined 2027 demands at the Musiphana and Runnymede Reservoirs.

Based on the good working condition of the existing pumps, it would be preferable to utilise the existing infrastructure as far as possible.

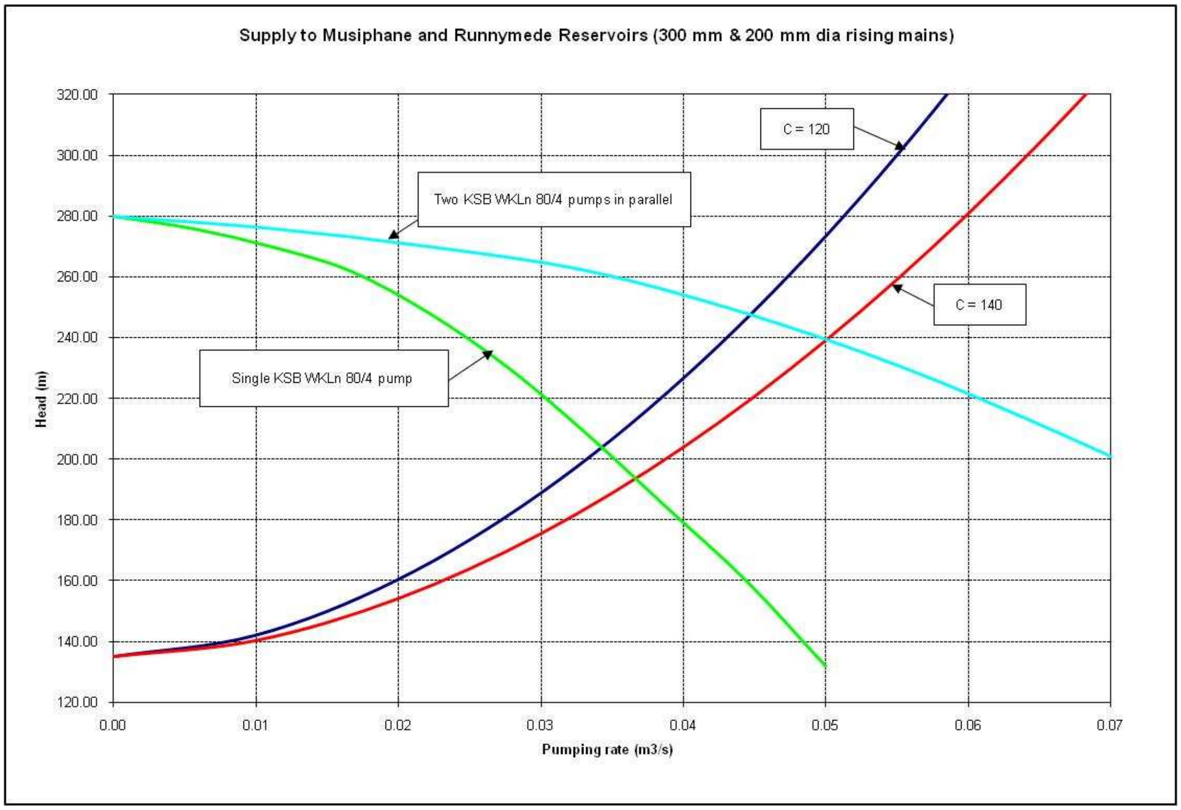


Figure 6.1 Characteristic curves for existing pipeline from WTW to Runnymede Reservoirs and pump curves of existing clear water pumps

It is evident from **Figure 6.1** that a pumped flow of approximately 50 ℓ/s could be delivered to the Runnymede Reservoirs, compared to flows of 27 ℓ/s and 37 ℓ/s required to meet the 2008 and 2027 demands, respectively. Due to the "surplus" capacity of the pumps, it would be possible to also deliver water to the Musiphana Reservoirs, which have demands of 20 ℓ/s and 28 ℓ/s for the 2008 and 2027 scenarios, respectively. **Figure 6.2** shows the characteristic system curves for the 300 mm diameter rising main from the WTW to the Musiphana Reservoirs, as well as the pump curves of the existing pumps fitted with 215 mm impellers.

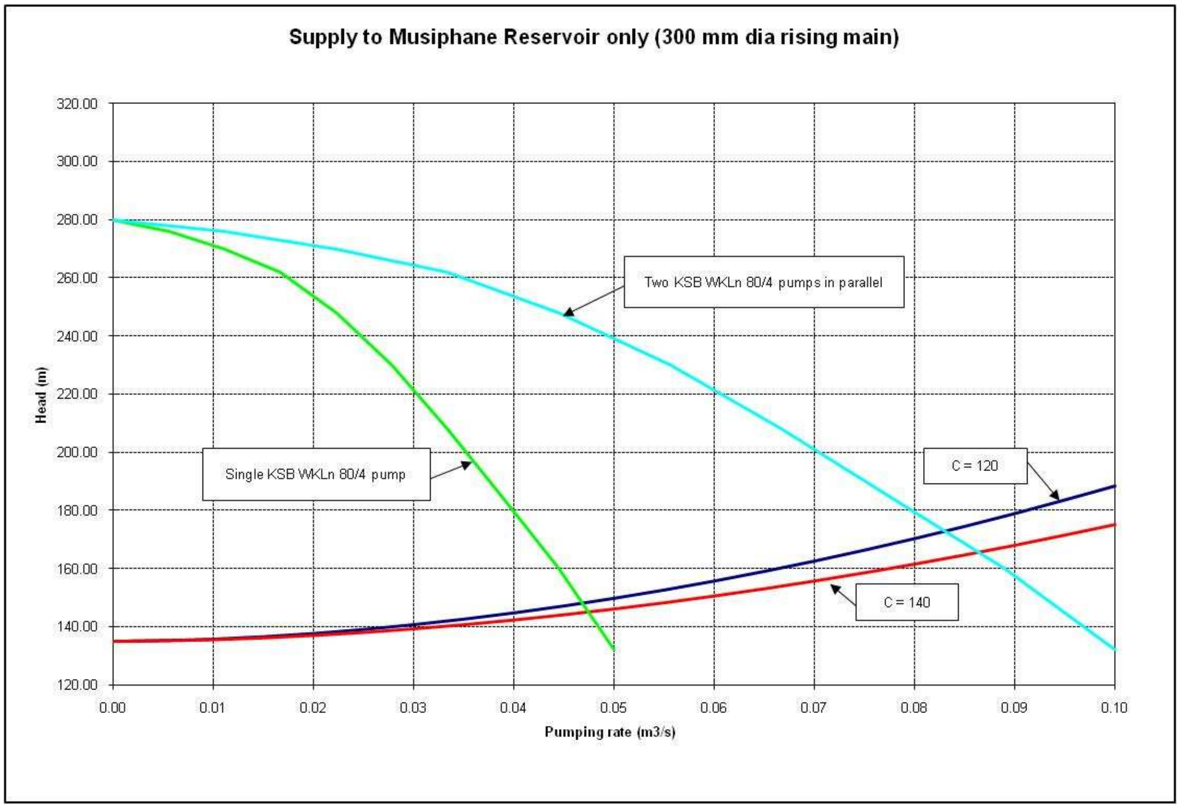


Figure 6.2 **Characteristic curves for existing pipeline from WTW to Musiphana Reservoirs and pump curves of existing clear water pumps**

It is evident from **Figure 6.2** that a pumped flow of more than 80 ℓ/s would be achieved with two pumps operating in parallel when pumping only to the Musiphana Reservoirs.

It can therefore be concluded that the existing clear water pumps should be used in conjunction with the existing 200 and 300 mm diameter rising mains from the WTW to the Musiphana and Runnymede Reservoirs to meet the demands at these reservoirs. The 110 kW motors are also adequate to perform the above duties, but the existing 220 mm impellers need to be trimmed to 215 mm to limit the power requirements to less than 110 kW when only one pump supplies water to the Musiphana Reservoirs.

6.3 OPTIMISATION OF RISING AND GRAVITY MAINS

6.3.1 Pipe material selection

The following assumptions were made regarding pipe materials as part of the optimisation process:

- Pipelines with diameters smaller than 300 mm would be manufactured from PVC-U; and
- Pipelines with diameters 300 mm and larger would be manufactured from GRP.

A Hazen-Williams friction coefficient of 130 was assumed for the pipeline optimisation.

No detailed waterhammer analyses were undertaken (with the exception of the existing Xihoko rising main), but it is anticipated that negative surge pressures could be experienced on all the rising mains. The various pipe manufacturers recommend the following to deal with negative surge pressures :

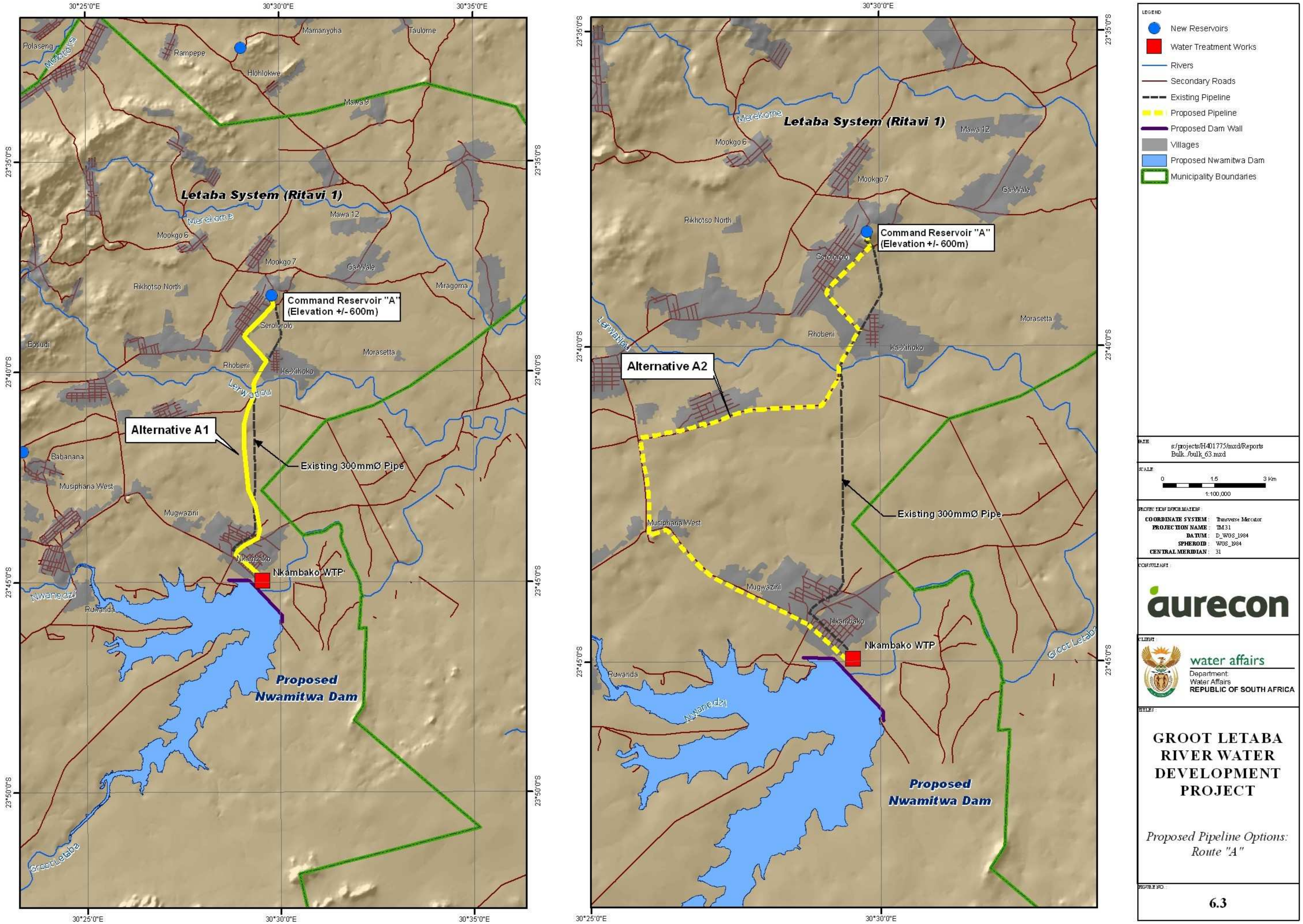
- Class 9 as a minimum on PVC-U pipes
- Class 16 as a minimum on PVC-M pipes
- A stiffness of SN 5000 on GRP pipes

The above recommendations were taken into account when determining pressure classes due to working pressures.

6.3.2 WTW to Command Reservoir A : new infrastructure

Figure 6.3 shows the two possible routes, i.e. Route A1 and A2, that were identified between the WTW and Command Reservoir A.

Table 6.2 shows the net present values calculated for Route A1 for different pipeline diameters, based on a flow of 293 ℓ/s.



Letaba System (Ritavi 1)
Command Reservoir "A"
(Elevation +/- 600m)
Alternative A1
Alternative A2
Existing 300mmØ Pipe
Nkambako WTP
Proposed
Nwamitwa Dam
Polaseng
Rampepe
Mamanyoha
Taulome
Hlohlokwe
Mawa 9
Mawa 12
Merekome
Mookgo 6
Mookgo 7
Ga-Wale
Rikhotso North
Miragoma
Serolorolo
Rhobeni
Ka-Xihoko
Morasetta
Letsitele
Babanana
Musiphana West
Mugwazini
Nkambako
Ruwanda
Nwanedzi
Groot Letaba
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30°30'0"E
30°35'0"E
23°35'0"S
23°40'0"S
23°45'0"S
23°50'0"S
LEGEND
New Reservoirs
Water Treatment Works
Rivers
Secondary Roads
Existing Pipeline
Proposed Pipeline
Proposed Dam Wall
Villages
Proposed Nwamitwa Dam
Municipality Boundaries
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CONSULTANT:
aurecon
CLIENT:
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA
TITLE:
GROOT LETABA RIVER WATER DEVELOPMENT PROJECT
Proposed Pipeline Options: Route "A"
FIGURE NO.:
6.3

Table 6.2 Route A1 net present values for a flow of 293 ℓ/s

Pipe diameter (mm)	Net present value (4%)	Net present value (6%)	Net present value (8%)
350	R 114,7 m	R 102,8 m	R 94,0 m
400	R 84,2 m	R 76,1 m	R 70,1 m
450	R 71,6 m	R 65,3 m	R 60,6 m
500	R 66,3 m	R 60,9 m	R 56,9 m
600	R 66,6 m	R 61,9 m	R 58,9 m
700	R 73,3 m	R 68,7 m	R 65,2 m

It is evident from **Table 6.2** that the optimum pipeline diameter for Route A1 and a flow of 293 ℓ/s, is 500 mm.

Table 6.2 shows the net present values calculated for Route A2 for different pipeline diameters, based on a flow of 293 ℓ/s.

Table 6.3 Route A2 net present values for a flow of 293 ℓ/s

Pipe diameter (mm)	Net present value (4%)	Net present value (6%)	Net present value (8%)
350	R 161,2 m	R 144,9 m	R 132,8 m
400	R 115,2 m	R 104,7 m	R 96,8 m
450	R 95,7 m	R 87,8 m	R 81,9 m
500	R 87,6 m	R 81,1 m	R 76,2 m
600	R 87,6 m	R 82,1 m	R 78,0 m
700	R 96,8 m	R 91,4 m	R 87,4 m

It is evident from **Table 6.3** that the optimum pipeline diameter for Route A2 and a flow of 293 ℓ/s, is 500 mm.

Table 6.4 provides a comparison between the two pipeline routes for the optimum pipeline diameter.

Table 6.4 Comparison between Routes A1 and A2 for a flow of 293 ℓ/s

Description	Route A1	Route A2
Pipeline length (m)	14 480	21 790
Optimum pipe diameter (mm)	500	500
Net present value @ 6%	R 60,9 m	R 81,1 m
Capital cost (Rand Million)	R 29,8 m	R 40,4 m
Pump duty	293 ℓ/s @ 195 m	293 ℓ/s @ 223 m

Note: The capital cost includes preliminary and general costs, but excludes contingencies, professional fees and VAT.

It is evident from **Table 6.4** that Route A1 is shorter than Route A2, which also results in a lower pumping head and hence lower operating costs. Route A1 is thus the preferred route due to the shorter length.

Route A1 was also optimised for a flow of 199 ℓ/s, which is the 2008 demand scenario. **Table 6.5** shows the net present values calculated for Route A1 for different pipeline diameters, based on a flow of 199 ℓ/s.

Table 6.5 Route A1 net present values for a flow of 199 ℓ/s

Pipe diameter (mm)	Net present value (4%)	Net present value (6%)	Net present value (8%)
350	R 60,5 m	R 55,1 m	R 51,1 m
400	R 51,1 m	R 46,9 m	R 43,8 m
450	R 48,7 m	R 45,0 m	R 42,4 m
500	R 48,7 m	R 45,3 m	R 42,8 m
600	R 54,3 m	R 51,0 m	R 48,6 m
700	R 62,7 m	R 59,3 m	R 56,8 m

It is evident from **Table 6.5** that the optimum pipeline diameter for Route A1 and a flow of 199 ℓ/s, is 450 mm. This would be the pipeline diameter required in the short-term. The additional construction cost associated with constructing a 500 mm diameter pipeline in lieu of a 450 mm diameter pipeline is approximately R2,4 m. This represents a reduction of 8% on the total construction cost of R 29,8 m for the 500 mm diameter pipeline and pump station scheme.

Due to the marginal reduction in construction costs, it is recommended that a 500 mm diameter pipeline be installed to meet the 2008 demands.

Figure 6.4 and **Figure 6.5** show the hydraulic gradelines for a 500 mm diameter pipeline along Route A1 for flows of 199 ℓ/s and 293 ℓ/s, respectively.

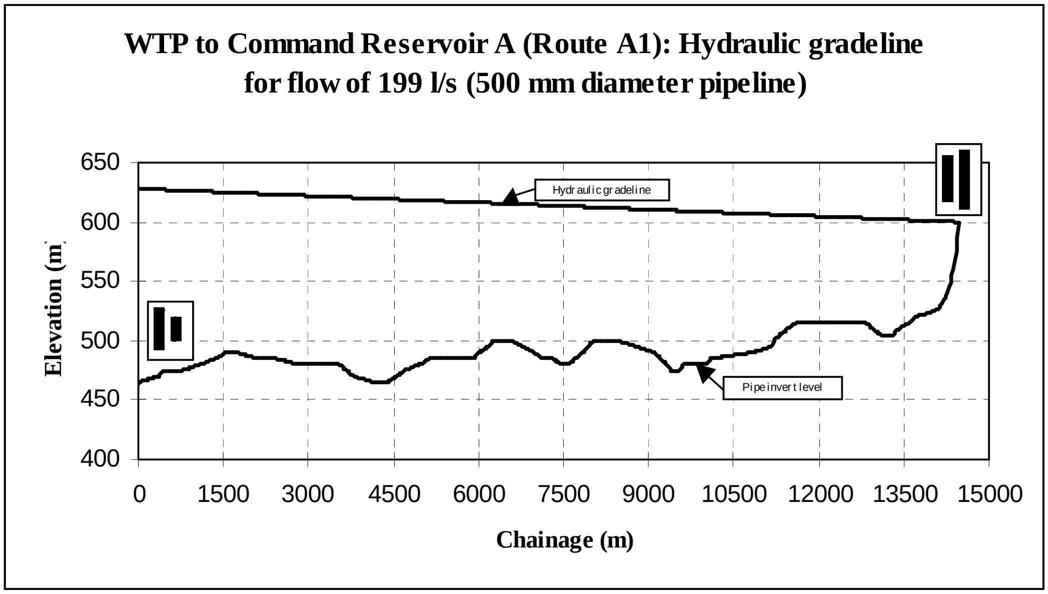


Figure 6.4 Hydraulic gradeline for flow of 199 ℓ/s in 500 mm diameter pipeline along Route A1

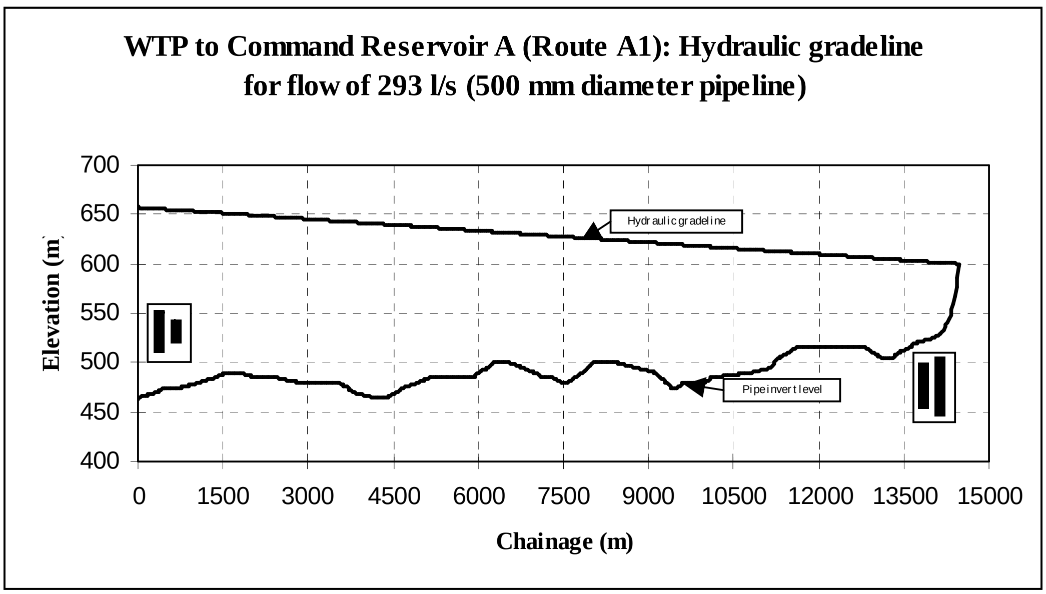


Figure 6.5 Hydraulic gradeline for flow of 293 ℓ/s in 500 mm diameter pipeline along Route A1

6.3.3 WTW to Command Reservoir A : Utilising the existing Xihoko Pipeline

Figure 6.3 shows the existing Xihoko 300 mm diameter pipeline from the existing WTW to Command Reservoir A, which follows approximately the alignment of Route A2. Following a site visit a concern was raised about the suitability of the pipe material used for this rising main. In order to assess whether or not this existing pipeline could be used, a waterhammer analysis was undertaken. The input data for the waterhammer analysis was obtained from the report entitled *Design Report for*

Letaba RWS Xihoko Rising Main, prepared by Endecon for Department of Water Affairs and Forestry (DWAF Project Number LP056).

The waterhammer analysis was based on a pumped flow rate of 90 ℓ/s.

The results of the waterhammer analysis are contained in **Appendix D** of this report.

The following analyses were undertaken:

- Steady state pressures, as well as the maximum allowable working pressures for the respective pipe classes (Figure 1 in **Appendix D**)
- The maximum surge pressures for a pump trip condition, as well as the maximum allowable surge pressures (Figure 2 in **Appendix D**)
- The minimum surge pressures for a pump trip condition (Figure 3 in **Appendix D**), and
- The maximum surge pressures for a pump start condition, as well as the maximum allowable surge pressures (Figure 4 of **Appendix D**)

The following conclusions can be drawn from the waterhammer analysis:

- The Class 6 and 9 PVC-U pipes are adequate to withstand the steady state pressures
- The maximum allowable surge pressures for the Class 6 and 9 PVC-U pipes are not exceeded during the pump trip condition.
- Negative surge pressures would be experienced along certain section of the pipeline during pump trip conditions. The manufacturers of PVC-U pipes recommend that a minimum of Class 9 be installed where negative pressures are experienced. The section downstream of stake value (SV) 8 580 m is Class 6 PVC-U pipes. Negative surge pressures are experienced from SV 7 700 m to SV 8 600 m, SV 10 900 m to SV 11 300 m, and SV 12 000 m to SV 12 580 m. This would therefore require replacing approximately 1 000 m of Class 6 pipe with Class 9 pipe.
- The maximum surge pressures for a pump start condition almost exceed the maximum allowable surge pressure at SV 9 280 m.

The following recommendation is made based on the surge analysis:

- Replace approximately 1 200 m of Class 6 PVC-U pipes with Class 9 PVC-U pipes.

Other design considerations

It appears that the booster pump station is an inline booster pump station, i.e. no sump is constructed at the suction side of the pump station.

An inline booster pump station would automatically correct any imbalance in flow with the pump station situated at the WTW, but poses the risk that, should the non-return valve be leaking, the static pressure would be transferred to the Class 6 and Class 9 pipes. The total static head is approximately 135 m (i.e. 610 m – 475 m), which exceeds the maximum allowable working pressures of the Class 6 and Class 9 pipes. It should therefore be considered to rather construct a sump at the suction side of the booster pump station or alternatively to install a pressure relief valve to protect the Class 6 and Class 9 pipeline.

Upgrades required to existing infrastructure

The following upgrades are recommended for the existing 355 mm Xihoko rising main:

- Replace approximately 1 200 m of Class 6 PVC-U pipes with Class 9 pipes;
- Install two new pumps (i.e. one duty, one standby) at the WTW to feed the 355 mm rising main (i.e. the existing pumps are not suited for the required duty).
- Construct a sump at the suction side of the booster pump station or install a pressure relief valve.

Cost estimate of proposed upgrades

Table 6.6 summarises the estimated capital costs of the proposed upgrades.

Table 6.6 Estimated capital costs to upgrade the existing Xihoko pipeline

Component	Description	Estimated cost (Rand)
Pipeline	1 200 m, Class 9 PVC-U	R 1 391 000
Pump station	Two KSB WKLn 125/3 pumpsets, pipework, electrical works and civil building	R 2 472 000
Pressure relief valve	-	R 50 000
	Total cost estimate (Rand)	**R 3 913 000**

The above amounts include preliminary and general costs but excludes contingencies, professional fees and VAT.

Impact on proposed future infrastructure

Assuming that the existing 355 mm rising main could deliver 90 ℓ/s to the Xihoko Reservoir, the flows that need to be handled in the proposed future rising mains would reduce to 109 ℓ/s and 203 ℓ/s for the 2007 and 2027 scenarios, respectively.

Route A1 was optimised for a flow of 109 ℓ/s (i.e. 199 ℓ/s – 90 ℓ/s), which is the 2008 demand scenario. **Table 6.7** shows the net present values calculated for Route A1 for different pipeline diameters, based on a flow of 109 ℓ/s.

Table 6.7 Route A1 net present values for a flow of 109 ℓ/s

Pipe diameter (mm)	Net present value (4%)	Net present value (6%)	Net present value (8%)
300	R35,2 m	R 32,6 m	R30868 m
350	R 33,0 m	R 30,9 m	R 29,2 m
400	R 32,4 m	R 30,4 m	R 29,0 m
450	R 34,5 m	R 32,5 m	R 31,1 m
500	R 36,8 m	R 34,9 m	R 33,5 m
600	R 44,4 m	R 42,3 m	R 40,8 m

It is evident from **Table 6.7** that the optimum pipeline diameter for Route A1 and a flow of 109 ℓ/s, is 400 mm. This would be the pipeline diameter required in the short-term in addition to the existing 355 mm PVC-U pipe. The construction cost associated with constructing a 400 mm diameter pipeline, including that of a pump station and the associated mechanical and electrical equipment, is R17,4 m.

Route A1 was optimised for a flow of 203 ℓ/s (i.e. 293 ℓ/s – 90 ℓ/s), which represents the 2027 demand scenario. **Table 6.8** shows the net present values calculated for Route A1 for different pipeline diameters, based on a flow of 203 ℓ/s.

Table 6.8 Route A1 net present values for a flow of 203 ℓ/s

Pipe diameter (mm)	Net present value (4%)	Net present value (6%)	Net present value (8%)
350	R 62,2 m	R 56,6 m	R 52,5 m
400	R 52,1 m	R 47,9 m	R 44,7 m
450	R 49,4 m	R 45,7 m	R 43,0 m
500	R 49,3 m	R 45,8 m	R 43,3 m
600	R 54,8 m	R 51,4 m	R 49,0 m
700	R 63,1 m	R 59,7 m	R 57,2 m

It is evident from **Table 6.8** that the optimum pipeline diameter for Route A1 and a flow of 203 ℓ/s, is 450 mm. This would be the pipeline diameter required in the long-term in addition to the existing 355 mm PVC-U pipe. The construction cost associated with constructing a 450 mm diameter pipeline, including that of a pump station and the associated mechanical and electrical equipment, is R23,6 m.

Recommendation

It is recommended that a 450 mm diameter pipeline be constructed partly due to the uncertainties related to the design of the existing 355 mm diameter pipeline, and also to ensure that the future water requirement in the Worcester/Molototsi system can be met. The 450 mm diameter pipeline is designed for a capacity of 203 ℓ/s, which is similar to the 2008 demand scenario, i.e. 199 ℓ/s. It would therefore be possible to still deliver 199 ℓ/s, even if problems are experienced with the 355 m diameter pipeline.

6.3.4 WTW to Command Reservoir B

Table 6.6 shows the two possible routes, i.e. Route B1 and B2, which were identified between the WTW and Command Reservoir B.

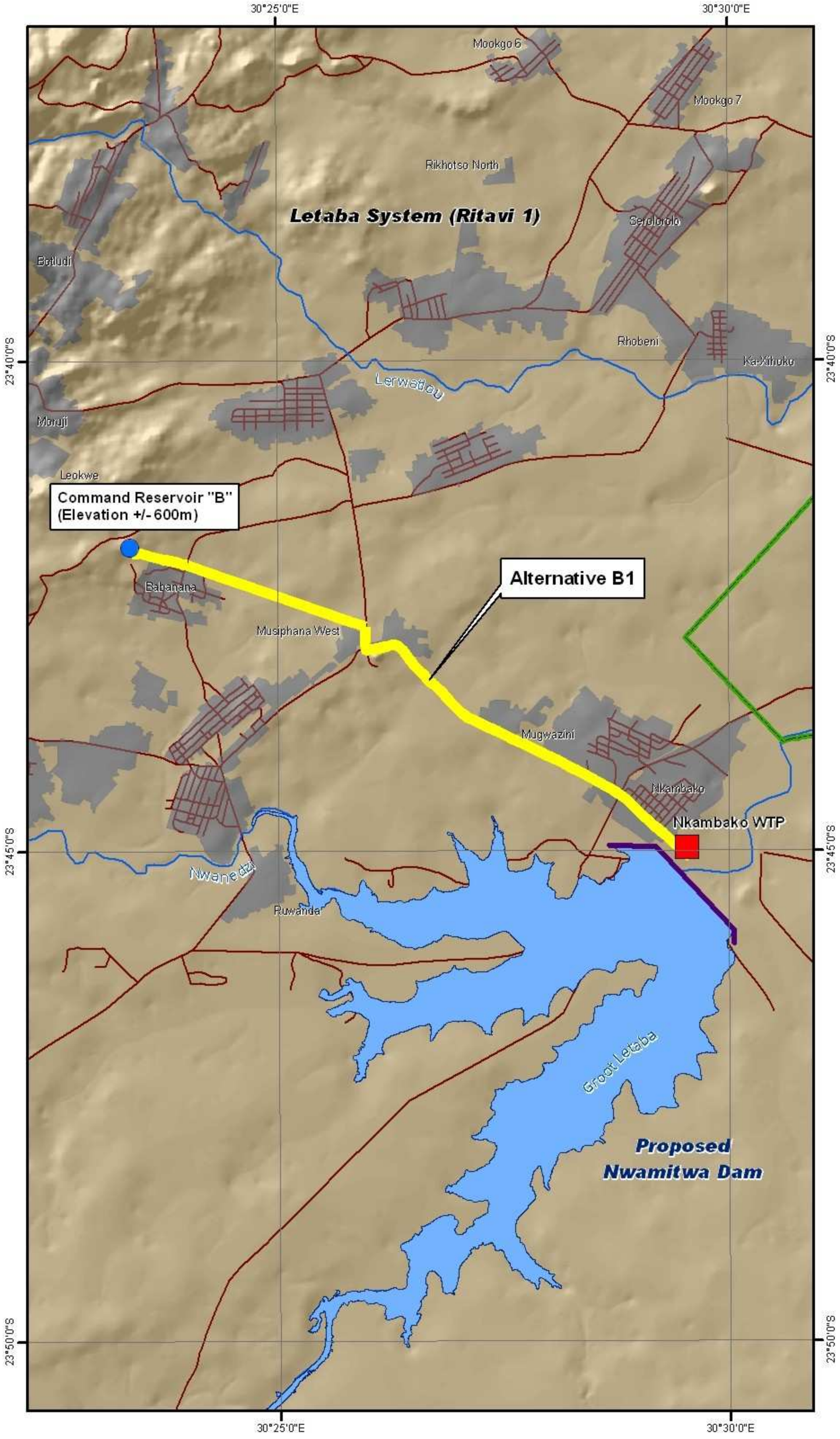
Table 6.9 shows the net present values calculated for Route B1 for different pipeline diameters, based on a flow of 172 ℓ/s.

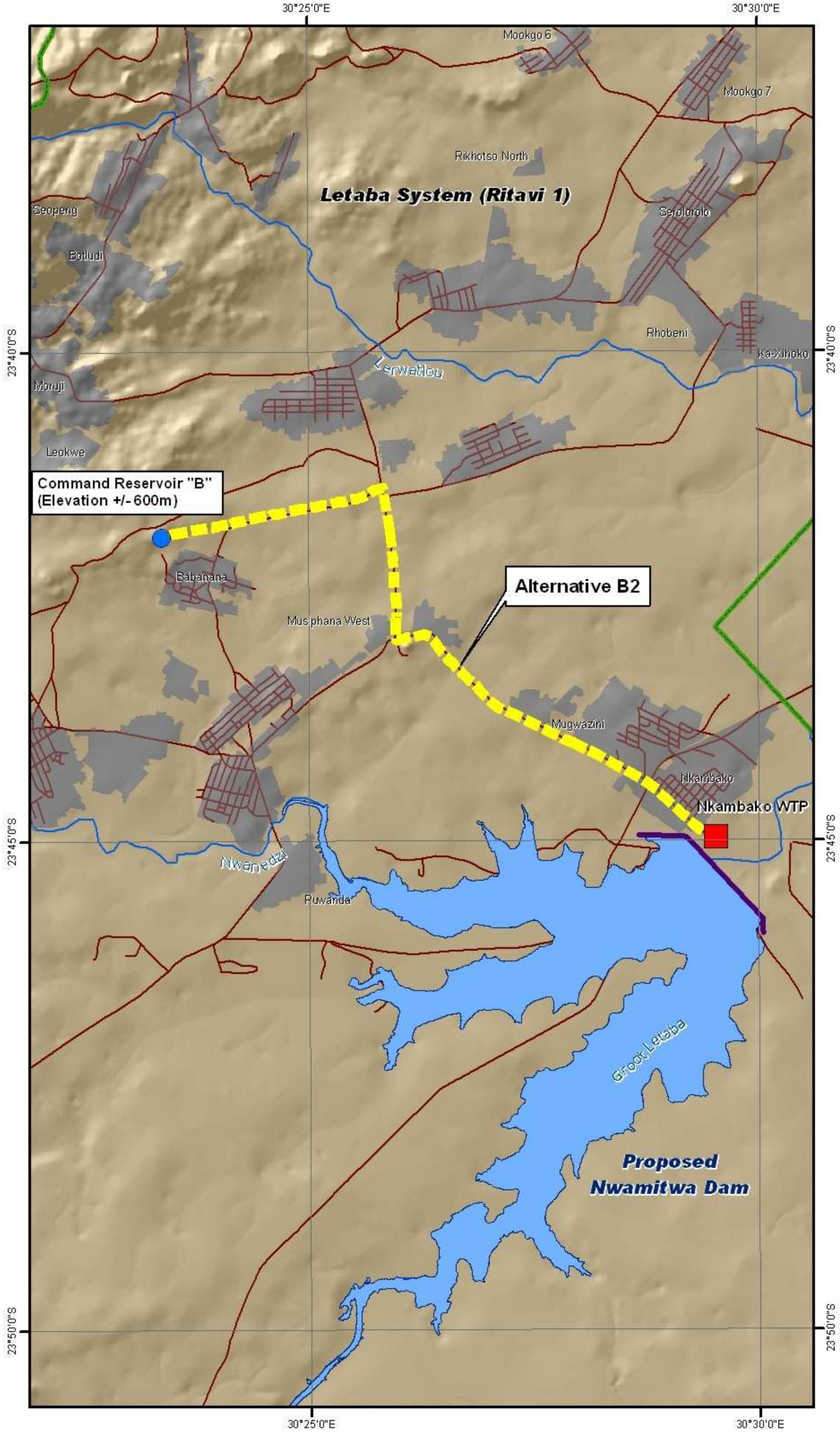
Table 6.9 Route B1 net present values for a flow of 172 ℓ/s

Pipe diameter (mm)	Net present value (4%)	Net present value (6%)	Net present value (8%)
300	R 58,3 m	R 52,8 m	R 48,8 m
350	R 46,4 m	R 42,6 m	R 39,7 m
400	R 41,9 m	R 38,7 m	R 36,3 m
450	R 41,5 m	R 38,6 m	R 36,4 m
500	R 42,4 m	R 39,6 m	R 37,6 m
600	R 47,7 m	R 45,0 m	R 42,9 m

It is evident from **Table 6.1** that the optimum pipeline diameter for Route B1 and a flow of 172 ℓ/s, is 450 mm for a discount rate of 6% or less, and 400 mm for a discount rate of 8%.

Table 6.10 shows the net present values calculated for Route B2 for different pipeline diameters, based on a flow of 172 ℓ/s.





LEGEND

- New Reservoirs
- Water Treatment Works
- Rivers
- Secondary Roads
- Proposed Pipeline
- Proposed Dam Wall
- Villages
- Proposed Nwamitwa Dam
- Municipality Boundaries

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SPHEROID: WGS_1984
CENTRAL MERIDIAN: 31

CONSULTANT:

aurecon

CLIENT:

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

TITLE:

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT

Proposed Pipeline Options: Route "B"

FIGURE NO.:

6.6

Table 6.10 Route B2 net present values for a flow of 172 ℓ/s

Pipe diameter (mm)	Net present value (4%)	Net present value (6%)	Net present value (8%)
300	R 66,5 m	R 60,3 m	R 55,8 m
350	R 52,3 m	R 48,1 m	R 44,9 m
400	R 46,7 m	R 43,3 m	R 40,8 m
450	R 46,3 m	R 43,2 m	R 40,9 m
500	R 47,3 m	R 44,4 m	R 42,2 m
600	R 53,7 m	R 50,8 m	R 48,6 m

It is evident from **Table 6.10** that the optimum pipeline diameter for Route B2 and a flow of 172 ℓ/s, is 450 mm for a discount rate of 6% or less, and 400 mm for a discount rate of 8%.

Table 6.11 provides a comparison between the two pipeline routes for the optimum pipeline diameter.

Table 6.11 Comparison between Routes B1 and B2 for a flow of 172 ℓ/s

Description	Route B1	Route B2
Pipeline length (m)	12 080	14 490
Optimum pipe diameter (mm)	450	450
Net present value @ 6%	R 38,6 m	R 43,2 m
Capital cost (Rand Million)	R 20,1 m	R 23,3 m
Pump duty	172 ℓ/s @ 167 m	172 ℓ/s @ 173 m

Note: The capital cost includes preliminary and general costs, but excludes contingencies, professional fees and VAT.

It is evident from **Table 6.11** that Route B1 is shorter than Route B2, which also results in a marginally lower pumping head and hence lower operating costs. The existing pipelines along Route B2 would be utilised to feed the Runnymede Reservoirs and would therefore not result in the installation of a smaller pipeline along this route due to the existing infrastructure. Route B1 is thus the preferred route due to the shorter length.

Route B1 was also optimised for a flow of 90 ℓ/s, which is the 2008 demand scenario.

Table 6.12 shows the net present values calculated for Route B1 for different pipeline diameters, based on a flow of 90 ℓ/s.

Table 6.12 Route B1 net present values for a flow of 90 ℓ/s

Pipe diameter (mm)	Net present value (4%)	Net present value (6%)	Net present value (8%)
300	R 27,8 m	R 25,9 m	R 24,5 m
350	R 27,7 m	R 26,1 m	R 24,9 m
400	R 28,3 m	R 26,7 m	R 25,5 m
450	R 30,4 m	R 28,8 m	R 27,6 m
500	R 32,5 m	R 30,9 m	R 29,7 m
600	R 39,0 m	R 37,3 m	R 36,0 m

It is evident from **Table 6.12** that the optimum pipeline diameter for Route B1 and a flow of 90 ℓ/s, is 350 mm for a discount rate of 6% or less, and 300 mm for a discount rate of 8%. Should only a 350 mm diameter pipeline be installed to meet the short-term demands, a 300 mm diameter pipeline would be required at a later stage for an effective diameter of 450 mm. The capital costs for 300 mm, 350 mm and 450 mm diameter rising mains are R10,1 m, R11,6 m and R14,5 m respectively. The additional construction cost associated with constructing a 450 mm diameter pipeline in place of a 350 mm diameter pipeline is approximately R 2,9 m. This represents a reduction of 14% on the total construction cost of R20,1 m for the 450 mm diameter pipeline and pump station scheme.

Due to the strategic nature of Command Reservoir B (i.e. it provides additional security of supply to the Thapane sub-system area) and the marginal difference in construction costs (i.e. when comparing a 350 mm diameter pipeline to a 450 mm diameter pipeline), it is recommended that a 450 mm diameter pipeline be installed to meet the 2008 demands.

Figure 6.7 and **Figure 6.8** show the hydraulic gradelines for a 450 mm diameter pipeline along Route B1 for flows of 90 ℓ/s and 172 ℓ/s, respectively.

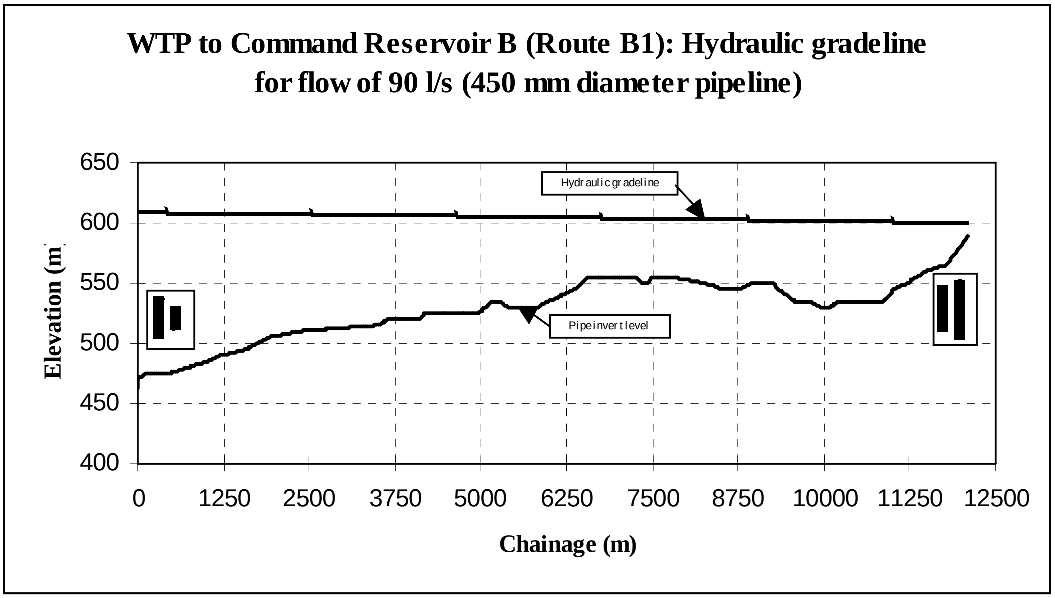


Figure 6.7 **Hydraulic gradeline for flow of 90 ℓ/s in 450 mm diameter pipeline along Route B1**

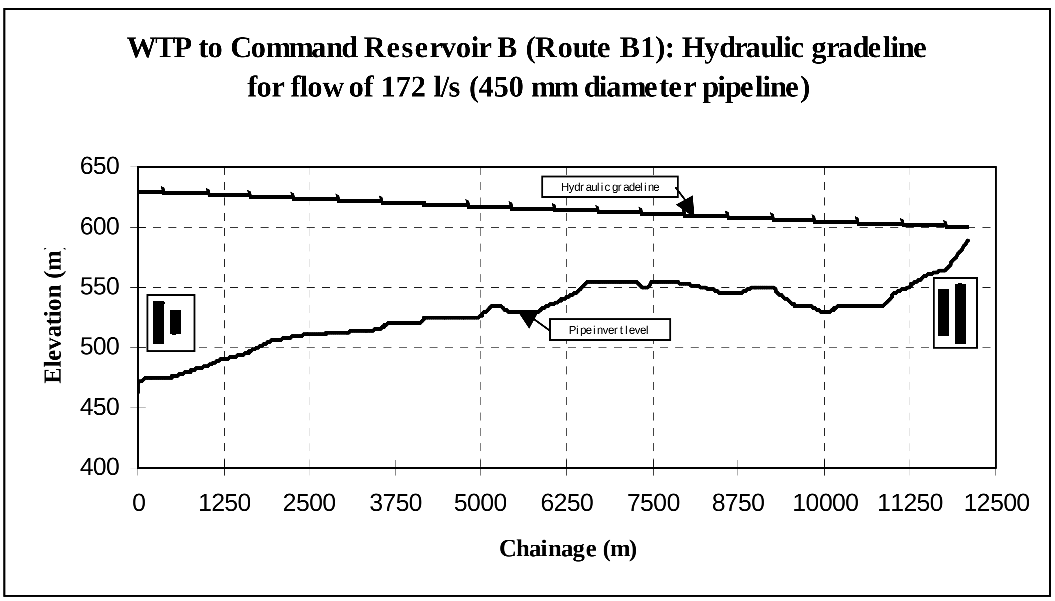
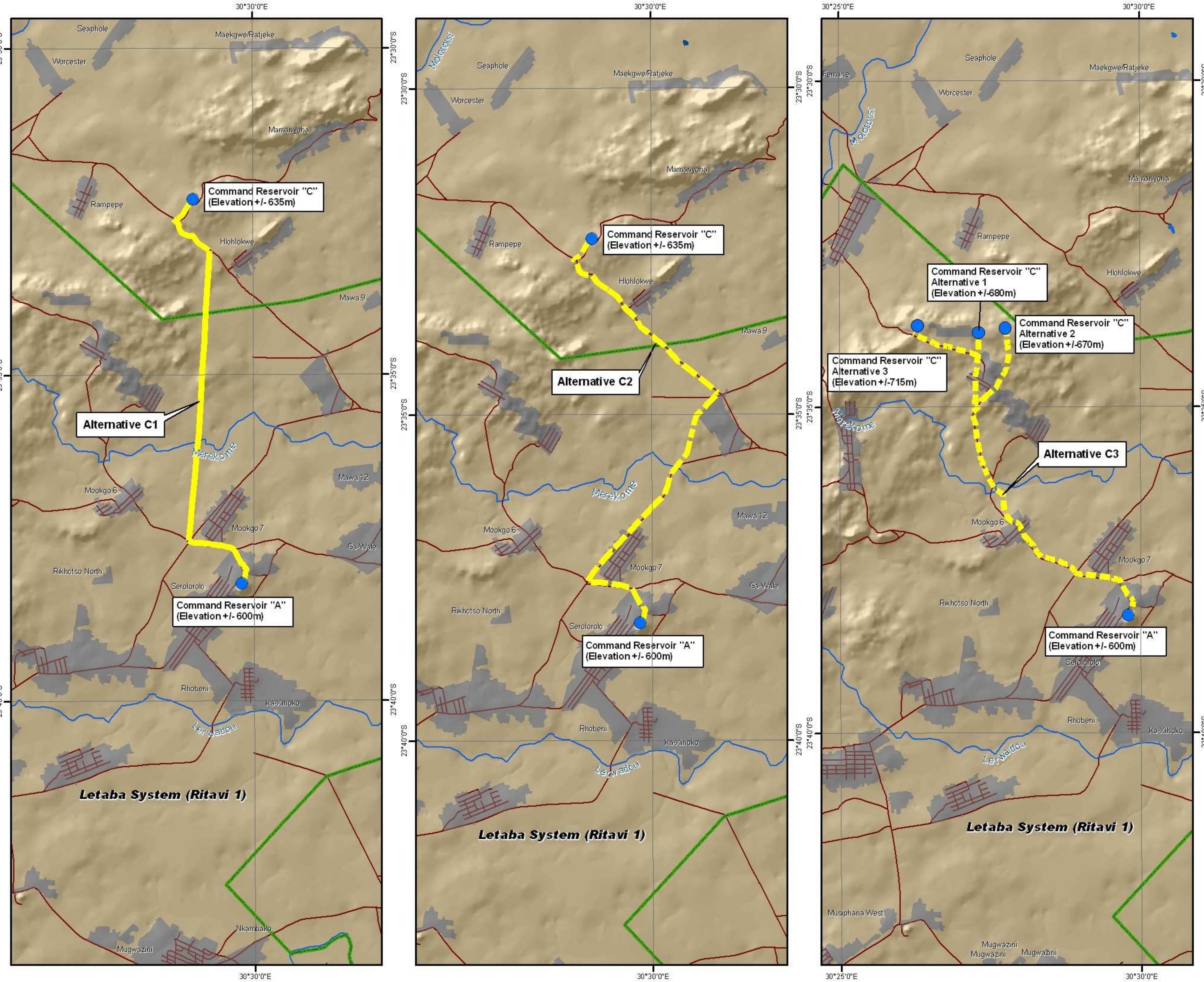


Figure 6.8 **Hydraulic gradeline for flow of 172 ℓ/s in 450 mm diameter pipeline along Route B1**

6.3.5 Command Reservoir A to Command Reservoir C

Figure 6.9 shows the two possible routes, i.e. Route C1 and C2, which were identified between Command Reservoir A and Command Reservoir C, as well as the pipeline route, C3, to the alternative reservoir site for Command Reservoir C.



LEGEND

- New Reservoirs
- Rivers
- Secondary Roads
- Proposed Dam Wall
- Proposed Pipeline
- Villages
- Proposed Nwamitwa Dam
- Municipality Boundaries

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SPHEROID :	WGS_1984
CENTRAL MERIDIAN :	31

CONSULTANT:

aurecon

CLIENT:

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

TITLE:

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT

Proposed Pipeline Options: Route "C"

FIGURE NO.

6.9

Table 6.3 shows the net present values calculated for Route C1 for different pipeline diameters, based on a flow of 99 ℓ/s.

Table 6.13 Route C1 net present values for a flow of 99 ℓ/s

Pipe diameter (mm)	Net present value (4%)	Net present value (6%)	Net present value (8%)
250	R 32,3 m	R 30,0 m	R 28,3 m
300	R 22,6 m	R 21,3 m	R 20,4 m
350	R 21,5 m	R 20,6 m	R 19,8 m
400	R 21,7 m	R 20,8 m	R 20,2 m
450	R 23,6 m	R 22,8 m	R 22,2 m
500	R 25,7 m	R 24,9 m	R 24,2 m

It is evident from **Table 6.13** that the optimum pipeline diameter for Route C1 and a flow of 99 ℓ/s, is 350 mm.

Table 6.14 shows the net present values calculated for Route C2 for different pipeline diameters, based on a flow of 99 ℓ/s.

Table 6.14 Route C2 net present values for a flow of 99 ℓ/s

Pipe diameter (mm)	Net present value (4%)	Net present value (6%)	Net present value (8%)
250	R 40,0 m	R 37,3 m	R 35,2 m
300	R 27,0 m	R 25,5 m	R 24,4 m
350	R 25,8 m	R 24,7 m	R 23,9 m
400	R 25,9 m	R 25,0 m	R 24,2 m
450	R 28,4 m	R 27,4 m	R 26,7 m
500	R 31,0 m	R 30,0 m	R 29,3 m

It is evident from **Table 6.14** that the optimum pipeline diameter for Route C2 and a flow of 99 ℓ/s, is 350 mm.

Table 6.15 Route C3 net present values for a flow of 92 ℓ/s

Pipe diameter (mm)	Net present value (4%)	Net present value (6%)	Net present value (8%)
250	R 34,5 m	R 31,9 m	R 29,9 m
300	R 26,5 m	R 24,7 m	R 23,4 m
350	R 26,0 m	R 24,5 m	R 23,3 m
400	R 26,4 m	R 25,0 m	R 23,9 m
450	R 28,5 m	R 27,0 m	R 25,9 m
500	R 30,6 m	R 29,2 m	R 28,1 m

It is evident from **Table 6.15** that the optimum pipeline diameter for Route C3 and a flow of 92 ℓ/s, is 350 mm.

Table 6.16 provides a comparison between the three pipeline routes for the optimum pipeline diameter.

Table 6.16 Comparison between Routes C1 and C2 for a flow of 99 ℓ/s and Route C3 for a flow of 92 ℓ/s

Description	Route C1	Route C2	Route C3
Pipeline length (m)	12 740	15 560	12 340
Optimum pipe diameter (mm)	350	350	350
Net present value @ 6%	R 20,6 m	R 24,7 m	R 24,5 m
Capital cost (Rand Million)	R 12,4 m	R 15,3 m	R 13,5 m
Pump duty	99 ℓ/s @ 73 m	99 ℓ/s @ 81 m	92 ℓ/s @ 153 m

Note: The capital cost includes preliminary and general costs, but excludes contingencies, professional fees and VAT.

It is evident from **Table 6.16** that Route C3 is the shortest, but is also the route with the highest static level, resulting in a higher net present value when compared to Route C1. The capital cost for Route C1 is also less than that of Route C3 due to the smaller pump station building, pumps and associated mechanical and electrical equipment. Route C1 is thus the preferred route due to the lower pumping head.

Route C1 was also optimised for a flow of 77 ℓ/s, which is the 2008 demand scenario. **Table 6.17** shows the net present values calculated for Route C1 for different pipeline diameters, based on a flow of 77 ℓ/s.

Table 6.17 Routes C1 net present values for a flow of 77 ℓ/s

Pipe diameter (mm)	Net present value (4%)	Net present value (6%)	Net present value (8%)
250	R 23,5 m	R 22,2 m	R 21,2 m
300	R 18,9 m	R 18,0 m	R 17,4 m
350	R 19,6 m	R 18,9 m	R 18,3 m
400	R 20,5 m	R 19,8 m	R 19,2 m
450	R 22,7 m	R 22,0 m	R 21,4 m
500	R 24,9 m	R 24,2 m	R 23,6 m

It is evident from **Table 6.17** that the optimum pipeline diameter for Route C1 and a flow of 77 ℓ/s, is 300 mm. Should only a 300 mm diameter pipeline be installed to meet the short-term demands, a 200 mm diameter pipeline would be required at a later stage for an effective diameter of 350 mm. The capital costs for 200 mm, 300 mm and 350 mm diameter rising mains are R7,2 m, R9,4 m and R11,0 m respectively. The additional construction cost associated with constructing a 350 mm diameter pipeline in place of a 300 mm diameter pipeline is approximately R1,6 m. This represents a reduction of 13% on the total construction cost of R12,4 m for the 350 mm diameter pipeline and pump station scheme.

Due to the marginal difference in construction costs (i.e. when comparing a 300 mm diameter pipeline to a 350 mm diameter pipeline), it is recommended that a 350 mm diameter pipeline be installed to meet the 2008 demands. The 350 mm diameter pipeline would also result in lower operating costs due to the lower pumping head, which would offset part of the higher initial capital costs.

Figure 6.10 and **Figure 6.11** show the hydraulic gradelines for a 350 mm diameter pipeline along Route C1 for flows of 77 ℓ/s and 99 ℓ/s, respectively.

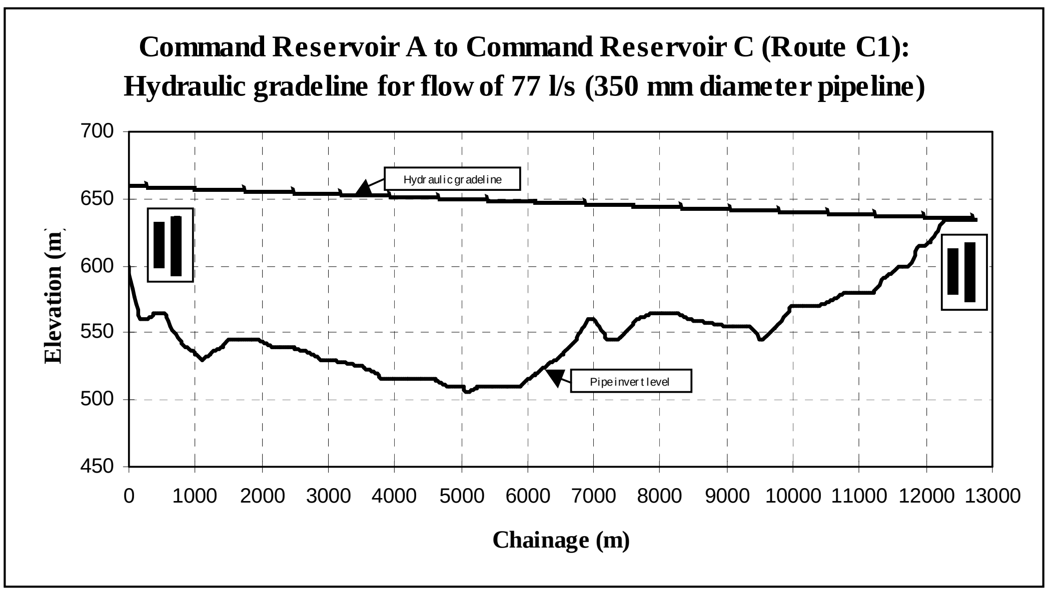


Figure 6.10 Hydraulic gradeline for flow of 77 ℓ/s in 350 mm diameter pipeline along Route C1

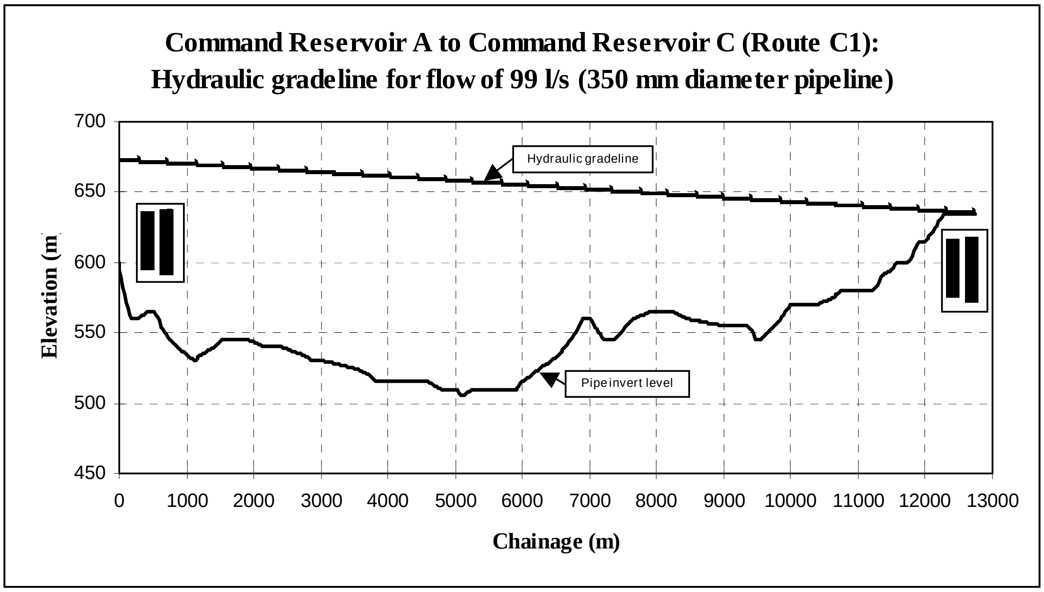
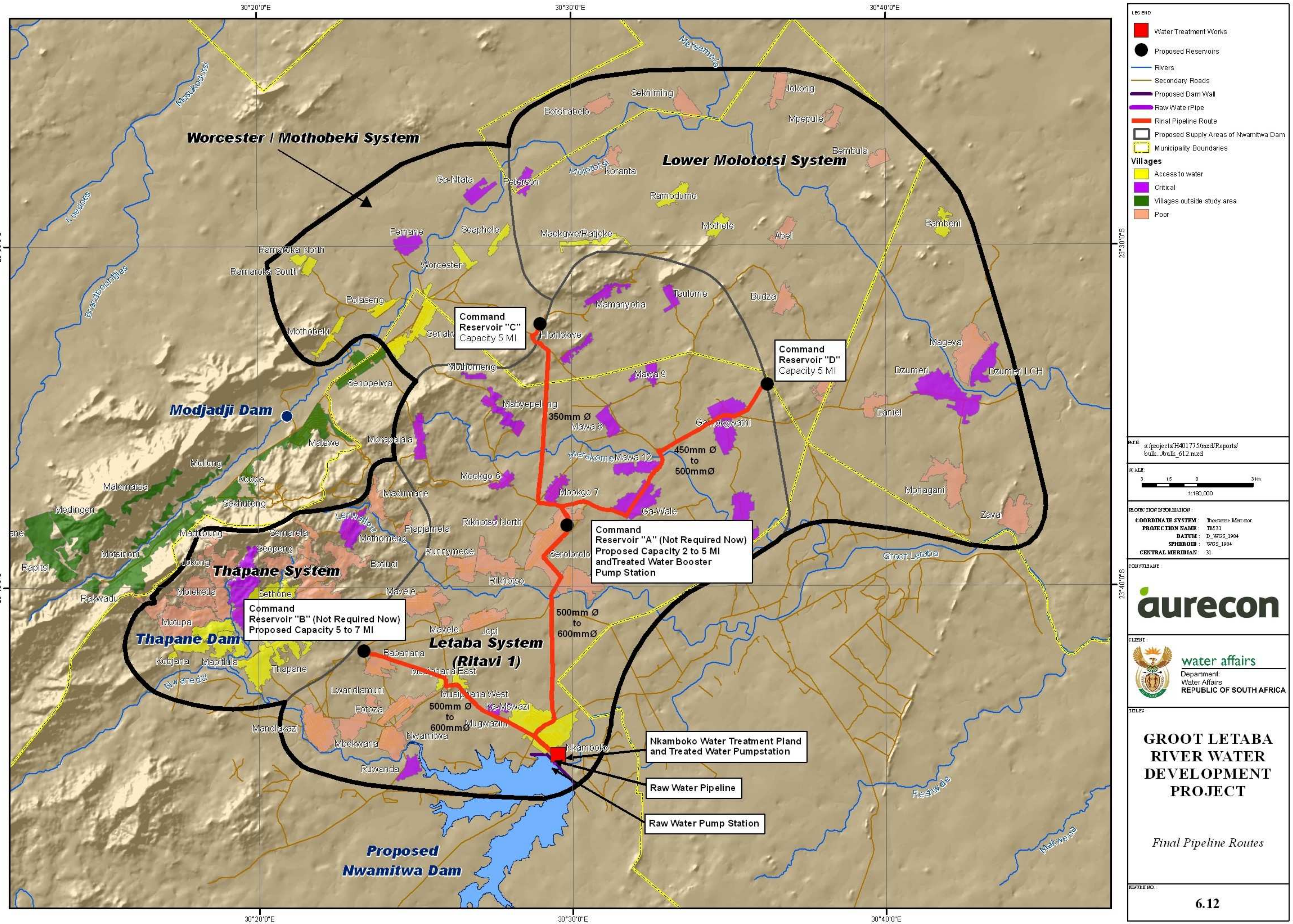


Figure 6.11 Hydraulic gradeline for flow of 99 ℓ/s in 350 mm diameter pipeline along Route C1

6.3.6 Command Reservoir A to Command Reservoir D

Figure 6.12 shows the proposed pipeline route, i.e. Route D1, between command reservoir A and D.



LEGEND
Water Treatment Works
Proposed Reservoirs
Rivers
Secondary Roads
Proposed Dam Wall
Raw Wate rPipe
Rinal Pipeline Route
Proposed Supply Areas of Nwamitwa Dam
Municipality Boundaries
Villages
Access to water
Critical
Villages outside study area
Poor
Worcester / Mothobeki System
Lower Molototsi System
Thapane System
Letaba System (Ritavi 1)
Modjadji Dam
Thapane Dam
Proposed Nwamitwa Dam
Command Reservoir "C" Capacity 5 Ml
Command Reservoir "D" Capacity 5 Ml
Command Reservoir "A" (Not Required Now) Proposed Capacity 2 to 5 Ml andTreated Water Booster Pump Station
Command Reservoir "B" (Not Required Now) Proposed Capacity 5 to 7 Ml
Nkamboko Water Treatment Pland and Treated Water Pumpstation
Raw Water Pipeline
Raw Water Pump Station
350mm Ø
450mm Ø to 500mmØ
500mm Ø to 600mmØ
500mm Ø to 600mmØ
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30°30'0"E
30°40'0"E
23°30'0"S
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SPHEROID : WGS_1984
CENTRAL MERIDIAN : 31
CONSULTANT
aurecon
CLIENT
water affairs
Department: Water Affairs
REPUBLIC OF SOUTH AFRICA
TITLE
GROOT LETABA RIVER WATER DEVELOPMENT PROJECT
Final Pipeline Routes
FIGURE NO.
6.12

A top water level of 555 m was assumed at command reservoir D, meaning that water could gravitate from command reservoir A, which has a top water level of 600 m. **Table 6.18** summarises the residual head at command reservoir D for the 2008 and 2027 demand scenarios for different pipeline diameters.

Table 6.18 Residual head at command reservoir D

Diameter (mm)	Residual head for 2008 demand scenario (75 ℓ/s)	Residual head for 2027 demand scenario (146 ℓ/s)
300	- 17	- 165
350	16	-54
400	30	-7
450	36	16
500	40	28

It is evident from **Table 6.18** that in order to meet the 2008 and 2027 demands under gravity, 350 mm and 450 mm diameter pipelines would be required, respectively.

The total length of the pipeline is approximately 16 080 m. The estimated construction costs for the 350 mm and 450 mm diameter pipelines are R13,8 m and R17,5 m, respectively (Note: The costs include preliminary and general costs, but excludes contingencies, professional fees and VAT).

Figure 6.13 shows the hydraulic gradeline for a 450 mm diameter pipeline long Route D1 for a flow of 146 ℓ/s.

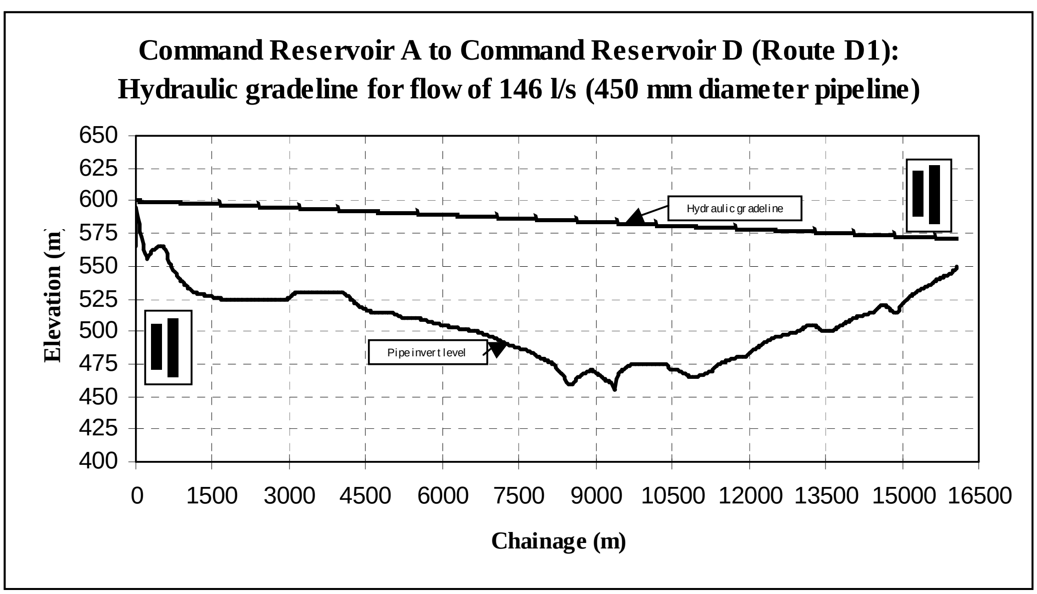


Figure 6.13 Hydraulic gradeline for flow of 146 ℓ/s in 450 mm diameter pipeline along Route D1

6.4 FINAL PIPELINE ROUTE SELECTION

The final pipeline routes from Nkambako WTW to all of the identified command reservoirs are contained in **Figure 6.14**. These optimised pipeline routes are based on lifecycle costing and take into account initial capital as well as ongoing operating costs.

The preliminary long sections for each of the final routes selected are contained in **Appendix F** of this Report.

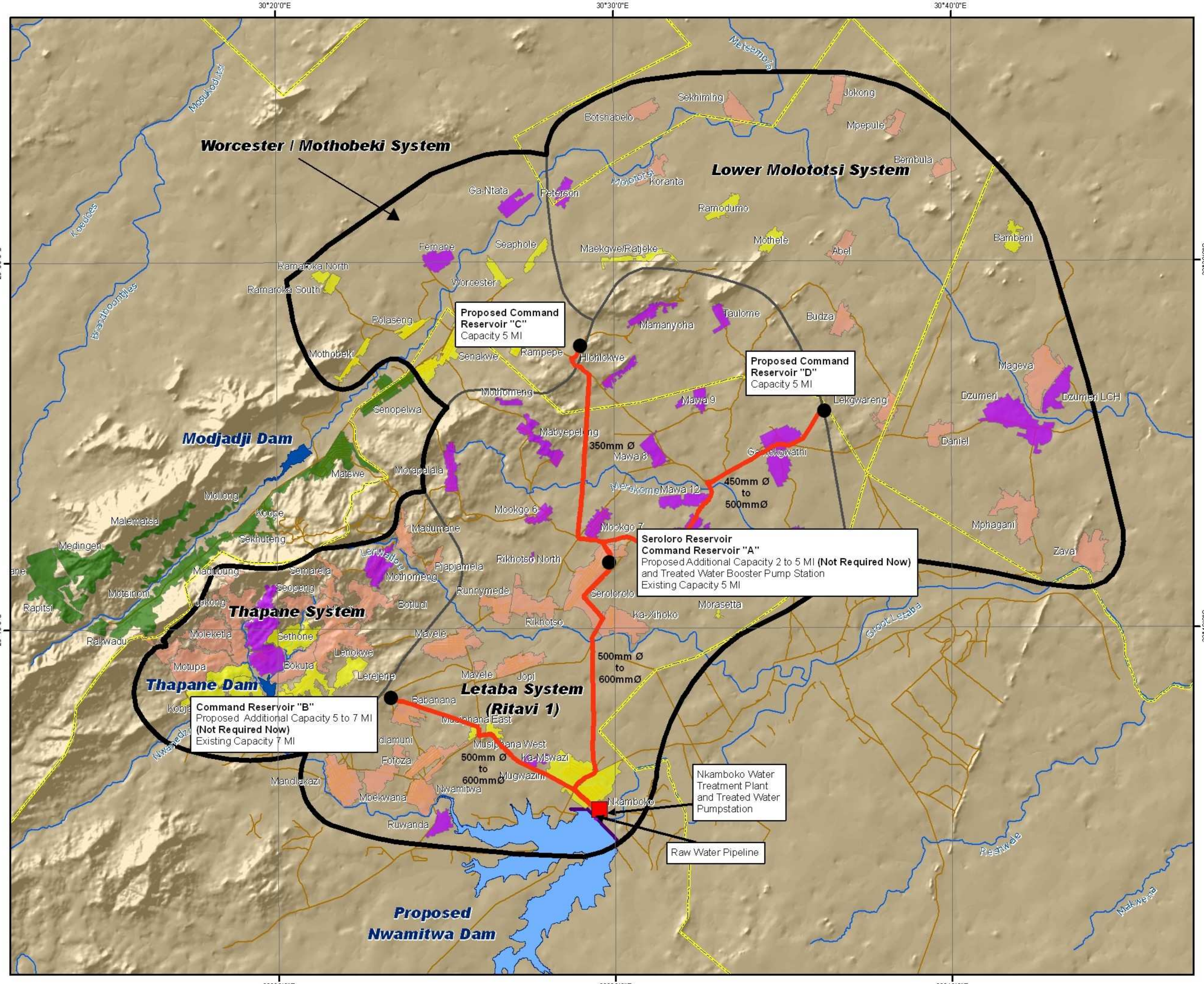
6.5 PUMP SIZING AND SELECTION

6.5.1 Pump duties

Table 6.19 provides a summary of the pump duties of the various clear water pump stations that would feed the command reservoirs.

Table 6.19 Pump duties of clear water pump stations

Location of pump station	Pumping to	Rising main diameter (mm)	2008 demand duty	2027 demand duty
WTW	Command Reservoir A	500	199 ℓ/s @ 164 m	293 ℓ/s @ 195 m
WTW	Command Reservoir B	450	90 ℓ/s @ 144 m	172 ℓ/s @ 167 m
Command Reservoir A	Command Reservoir C	350	77 ℓ/s @ 60 m	99 ℓ/s @ 73 m



LEGEND

- Water Treatment Works
- Proposed Reservoirs
- Rivers
- Secondary Roads
- Proposed Dam Wall
- Raw Water Pipe
- Final Pipeline Route
- Dams
- Proposed Supply Areas of Nwamitwa Dam
- Municipality Boundaries

Villages

- Access to water
- Critical
- Villages outside study area
- Poor

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CENTRAL MERIDIAN :	31

CONSULTANT:

aurecon

CLIENT:

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

TITLE:

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT

Recommended Pipeline Routes

FIGURE NO.:

6.14

6.5.2 Pump type selection

The following are typical pump types that are commonly utilised for pumping potable water:

- End-suction centrifugal pumps
- Multi-stage centrifugal pumps
- Horizontal split-casing pumps

Table 6.20 provides the typical operating range of the above pump types, assuming that 4-pole motors (i.e. operating at 1 480 rpm) would be used.

Table 6.20 Operating range of different pump types

Pump type	Flow range (per pump)	Pressure range
End-suction centrifugal	1 ℓ/s to 500 ℓ/s	5 m to 90 m
Multi-stage centrifugal	1 ℓ/s to 125 ℓ/s	5 m to 270 m
Horizontal split casing	25 ℓ/s to > 2 500 ℓ/s	7 m to 140 m

When comparing the pump duties shown in **Table 6.20** with the operating range of the different pumps, it is evident that multi-stage centrifugal pumps would be best suited for the two pump stations at the WTW, whereas end-suction or multi-stage centrifugal pumps could be considered for the pump station at command reservoir A. The pump selection for the preliminary pump station layouts is therefore based on multi-stage centrifugal pumps.

6.5.3 Characteristic curves and pump selection

Two pump stations need to be constructed at the WTW to pump treated water to command reservoirs A and B, respectively. It would be preferable to standardise on the pumps installed in these pump stations in order to reduce the stand-by capacity (i.e. share a stand-by pump), to reduce the amount of spares to be kept on site, and to simplify operation and maintenance of the pump stations. Furthermore, it would also be preferable that the pumping capacity of the pumps installed to meet the 2008 demands, could be increased by merely replacing the impellers, i.e. the pumps should not be fitted with full-size impellers to meet the 2008 demand and the motor sizes should be adequate to deal with the increase power requirements should the impeller size be increased at a later stage.

Figure 6.15 shows the characteristic curves for the 500 mm diameter rising main to Command Reservoir A, based on Hazen-Williams coefficients of 120 and 140, as well as the pump curves of a KSB WKLn 150/5 pump fitted with 340 mm impellers, and operating at 1 480 rpm.

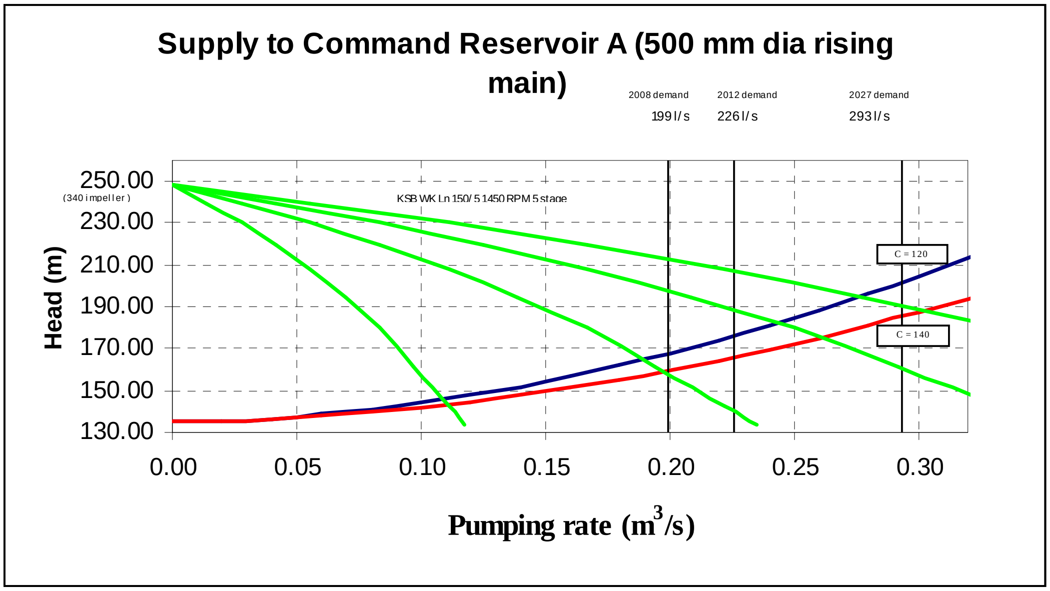


Figure 6.15 Characteristic curves for 500 mm pipeline to Command Reservoir A with KSB WKLn150/5 pump curves (340 mm impeller)

It is evident from **Figure 6.15** that two pumps in parallel would be able to deliver a flow of 199 ℓ/s, whereas three pumps in parallel would deliver approximately 260 ℓ/s. Four pumps in parallel would be able to deliver the 2027 demand of 293 ℓ/s. However, it would also be possible to achieve a flow of 293 ℓ/s with three pumps in parallel, provided that the impeller size is changed to 360 mm, as shown in **Figure 6.16.**

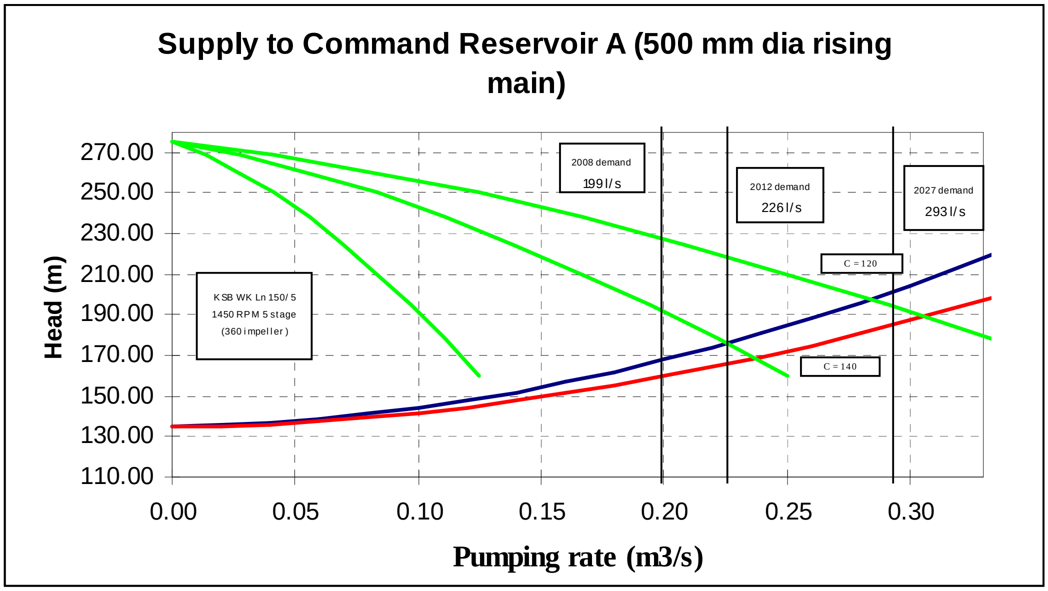


Figure 6.16 **Characteristic curves for 500 mm pipeline to Command Reservoir A with KSB WKLn150/5 pump curves (360 mm impeller)**

Figure 6.17 shows the characteristic curves for the 450 mm diameter rising main to Command Reservoir B, based on Hazen-Williams coefficients of 120 and 140, as well as the pump curves of a KSB WKLn 150/5 pump, fitted with 340 mm impellers, and operating at 1 480 rpm.

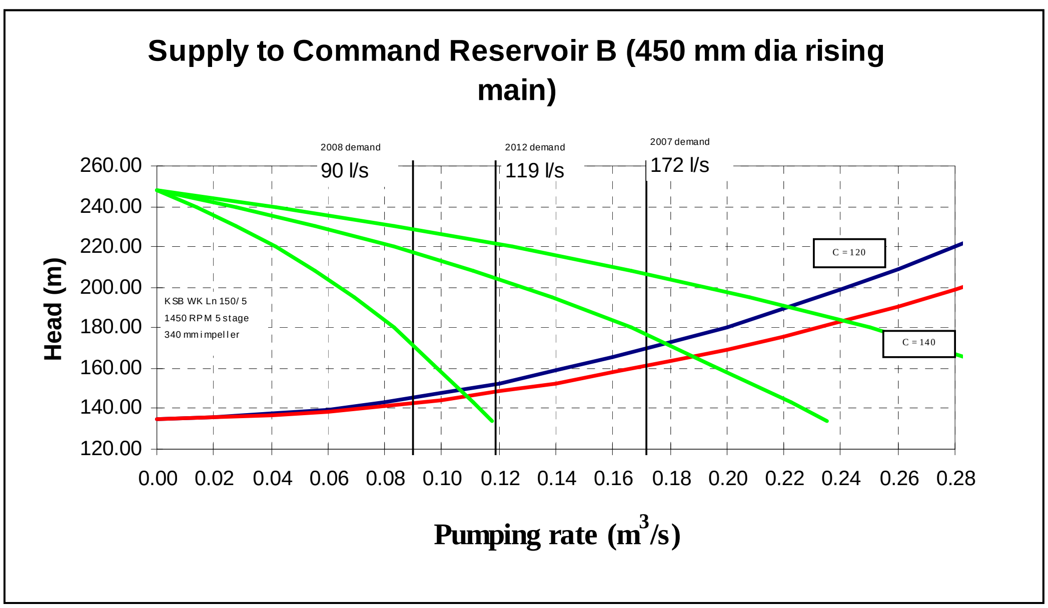


Figure 6.17 **Characteristic curves for 450 mm pipeline to Command Reservoir B with KSB WKLn150/5 pump curves (340 mm impeller)**

It is evident from **Figure 6.17** that one pump can meet the 2008 demand, whereas two pumps operating in parallel would meet the 2027 demand.

It would therefore be possible to install identical pumps to meet the demands at command reservoirs A and B.

Figure 6.18 shows the characteristic curves for the 350 mm diameter rising main from command reservoir A to command reservoir C, based on Hazen-Williams coefficients of 120 and 140, as well as the pump curves of a KSB WKLn 100/4 pump, fitted with 265 mm impellers, and operating at 1 480 rpm.

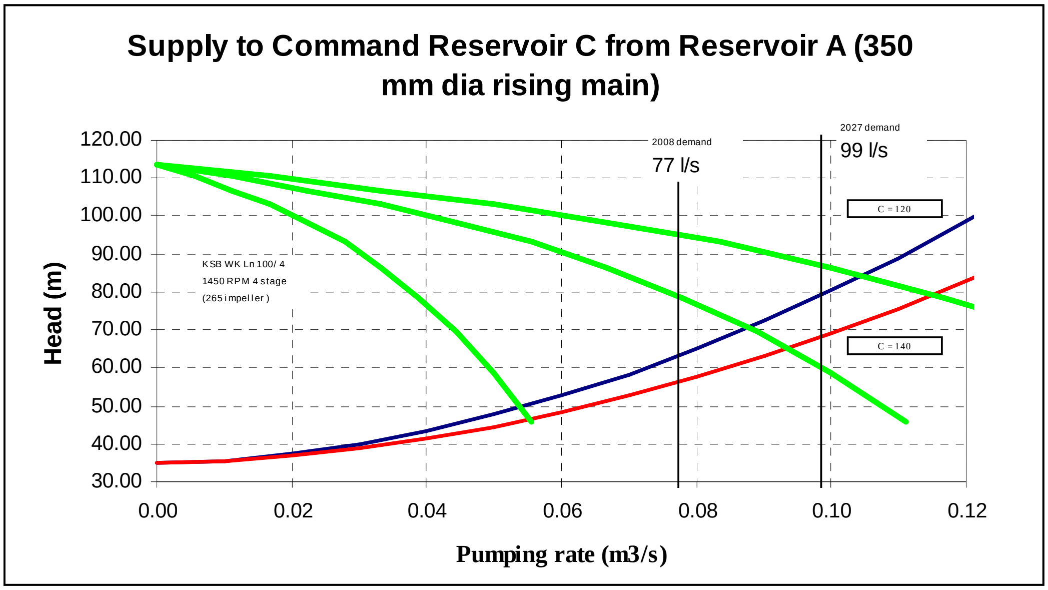


Figure 6.18 Characteristic curves for 350 mm pipeline from Command Reservoir A to Command Reservoir C with KSB WKLn100/5 pump curves (265 mm impeller)

It is evident from **Figure 6.18** that the 2008 demand could be met with two pumps operating in parallel and that the 2027 demand would be met with three pumps operating in parallel initiative.

6.5.4 Preliminary pump station layouts

The preliminary layout of the proposed pump stations is shown in **Appendix G** of this Report.

7. WATER TREATMENT WORKS

7.1 DESIGN CRITERIA

The following design criteria will apply:

Treated water quality: SANS 241:2006 Class 1.

Maximum velocity in pipelines:

Gravity:	1,5 m/s
Pump suction:	1,5 m/s
Pump delivery:	2,5 m/s

Rapid mix shear	:	750 to 1 000 s^{-1}
Flocculation shear and retention	:	In accordance with laboratory tests.
Sedimentation loading (horizontal flow)	:	Depends on flocc tests (1 m/h)
Filtration rate	:	5 to 7 $m^3/m^2/h$
Disinfection	:	Ct for disinfection of bacteria and viruses

7.2 CAPACITY

The Nkambako WTW has a capacity of 12 Mℓ/d (including the recently constructed 6 Mℓ/d addition). In view of the uncertainty associated with the current and future water requirements it is proposed that any future upgrading be undertaken in increments of 12 Mℓ/d. The High Level Service water requirement scenario indicates that the capacity of the WTW (based on peak week water requirements) should be 45 Mℓ/d in 2027. This water requirement assumes that all the settlements in the logical supply area of the proposed Nwamitwa Dam have installed reticulation down to village level. The preliminary design is therefore based on the provision of 12 Mℓ/d modules.

7.3 REQUIRED QUALITY OF TREATED WATER

The treated water must comply with the requirements of SANS Class I specification.

7.4 FUTURE RAW WATER QUALITY

It is noted that some limited urban development exists within the catchment of the proposed dam and in fact is close to the high water mark. It can therefore be expected that raw water quality will decline over time, particularly as regards to orthophosphate and nitrate, and that a degree of eutrophication may occur in the future. It is recommended that adequate sanitation be provided by the Water Service Authority in order to limit the danger of bacteriological contamination of the water source.

The following long-term changes may occur:

- Slightly lower pH
- Increase in dissolved metals, Fe and Mn, in bottom water
- Increase in organic carbon associated with algae
- Possible increase in turbidity and TDS
- Possible increase in e-coli

It is therefore important that the water treatment process be designed for the possible long term water quality that can be expected.

7.5 PRELIMINARY PROCESS

The following preliminary process is based on the limited water quality data available. The proposed process is shown on the Water Treatment Works Flow Diagram (see **Appendix H**) and is described below.

7.5.1 Chemical dosing

1. *Dosing of lime for pH correction for optimum flocculation and to attain a final water with a positive calcium carbonate precipitation potential.*

   Dosing of a coagulation chemical, as determined in laboratory testing, probably a poly-aluminium chloride or a polyelectrolyte.

2. Rapid mixing of chemicals into raw water

   It is proposed that the chemicals will be mixed into the raw water at a constriction in the raw water inlet pipe. Research has indicated that this is the most efficient mixing device for turbid waters.

Provision will be made in the design for the future addition of an oxidant to oxidise divalent iron and manganese prior to sedimentation.

7.5.2 Flocculation

Flocculation will take place either in a hydraulically mixed flocculation channel or in a series of three mechanically mixed tanks. A final decision as to the units to be used will be taken at detailed design tests after laboratory determination of the flocculation constants.

The retention time and mixing intensity will be determined by laboratory tests at detailed design stage. Retention time is expected to be of the order to 20 minutes.

7.5.3 Liquid solids separation

Deep bed direct filtration will be suitable for the low and median turbidity levels recorded in **Table 2.1**. Filtration will however not be suitable for the peak levels of turbidity shown. In view of the fact that the turbidity may well increase in the future it is proposed to use horizontal flow sedimentation tanks as the liquid solids separation unit.

As mentioned above, it is probable that algae concentrations will increase in the future. It is therefore proposed to design the plant layout so that flotation units can be inserted at the head of the works to cope with this eventuality.

7.5.4 Filtration

Filtration will be by means of rapid gravity sand filters. The design load will be of the order of 5 to 7 $m^3/m^2/h$. A minimum of four declining rate filters is proposed.

It is proposed that filters having a false floor system shall be used and outlet control shall be by means of an outlet siphon and partialisation box.

Backwash shall be by means of a reverse flow of water, followed by a combined flow of air and reduced water wash and a final rinse of a full water wash.

To accommodate the water wash rates required it is proposed that three half duty pumps be provided, two duty and one standby.

7.5.5 Stabilisation

As mentioned in Item 1 above, the initial lime dose will be set to produce a final water that is neither corrosive nor aggressive, i.e. a water with a positive calcium carbonate precipitation potential.

7.5.6 Disinfection

Disinfection will be by means of chlorine addition. The chlorine dose and retention time will be calculated based on modern theory to ensure that a kill of bacteria and viruses is achieved. An additional chlorinator will be installed to dose chlorine to the new Module 3.

The clearwell will be fitted with a level meter.

7.5.7 Process control

It is proposed that the following functions shall be automated:

- Adjustment of pH by the addition of lime. A pH meter should be installed at the head of the flocculation channel and the lime feeder should be automatically adjusted to attain a stable pH with respect to calcium carbonate precipitation potential.

- Filter backwash sequence. The filter wash sequence should be initiated by the plant operator. Thereafter the sequence shall be automatically executed. To this end all filter valves will be fitted with actuators.

- Shut down of chlorine drums in the event of a leak. A chlorine leak detector should be installed in the chlorine drum store. An air supply plant should be provided which will automatically close the chlorine drum valves when a leak is detected and an alarm should be sounded. The chlorine drums must be manually opened once the accumulated gas has been cleared.

- Operator's station. A man machine interface (MMI) should be provided at the operator's station which will indicate all the parameters and from which the operator should be able to initiate filter wash.

7.6 PRELIMINARY LAYOUT

The preliminary layout of the proposed extension to the Nkambako WTW is contained in **Appendix H** of this report.

8. RAW WATER PIPELINE AND PUMP STATION

8.1 DESIGN CRITERIA AND METHODOLOGY

This section deals with the preliminary optimisation of the raw water supply from the proposed Nwamitwa Dam to the WTW.

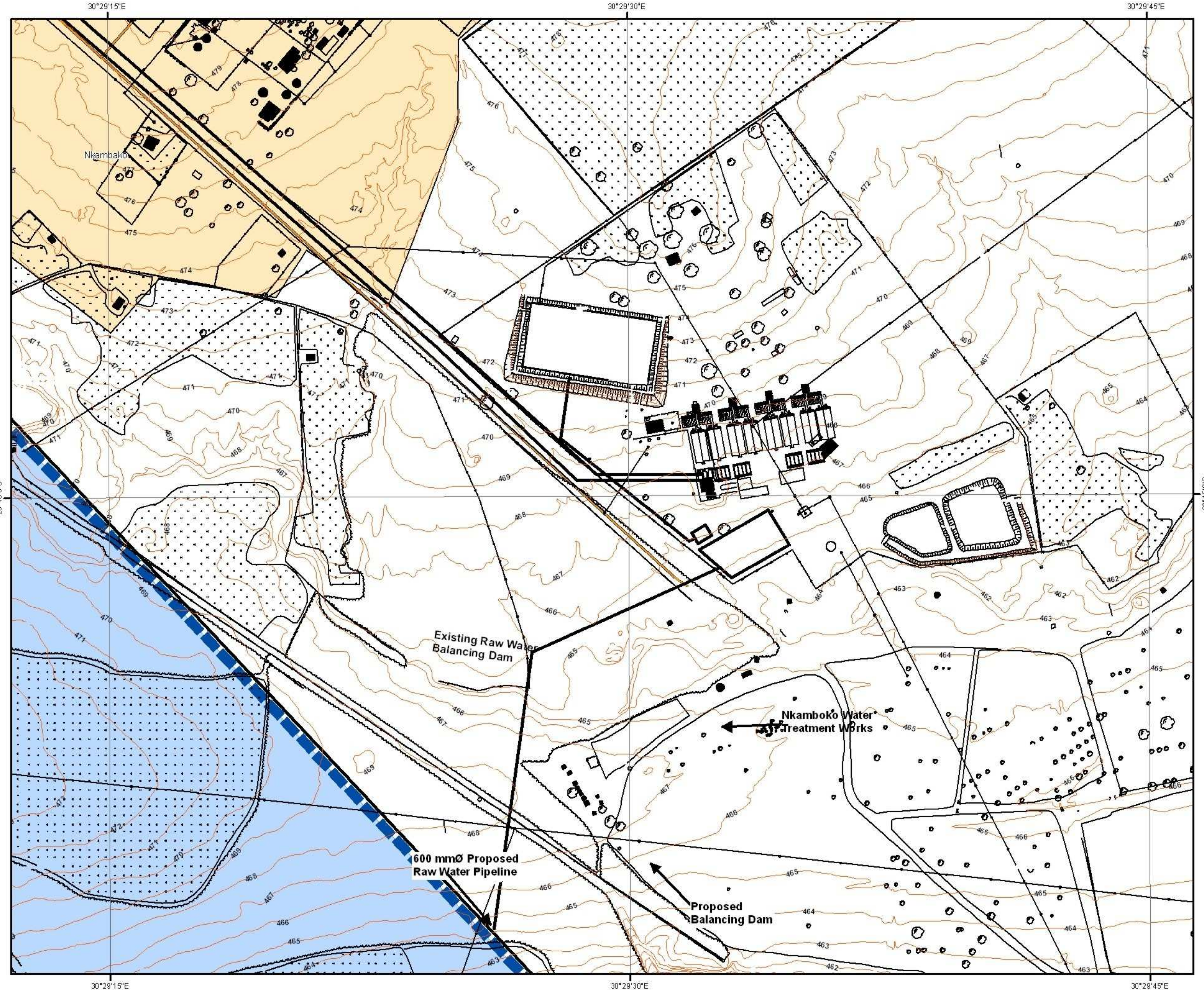
8.1.1 Operation of the raw water supply system

The existing raw water balancing dam at the WTW has a full supply level of approximately 474 m, whereas the operating level in the Nwamitwa Dam is likely to fluctuate from 470 m (i.e. 15% full) to 479,5 m (i.e. full supply level). It is therefore necessary to design the system to allow the filling of the balancing dam under gravity when the water level in the Nwamitwa Dam is high enough. Pumping is necessary when the water level in Nwamitwa Dam is lower than that in the balancing dam.

It would not be possible to locate the pump station at the Nwamitwa Dam, as the fluctuating water level makes it impossible to cover the complete operating range in flows (even when equipping the pumps with variable speed drives). The control of the switching from gravity to pumping mode, and *vice versa*, would also be complicated.

The preferred method of operation would be a hydraulically controlled system whereby the existing balancing dam would be filled under gravity when the water level in the Nwamitwa Dam is above 474 m, and a new balancing dam with a full supply level of 465 m to 467 m is filled when the water level in Nwamitwa Dam drops below 474 m. Water would then be pumped from the lower balancing dam to the existing balancing dam against a fixed head. This option would be suitable for fixed speed motors and would simplify the stopping and starting of the pumps, which would be regulated by the water level in the existing balancing dam.

Figure 8.1 shows the location of the WTW, the existing balancing dam, the dam wall of the proposed Nwamitwa Dam, the proposed pipeline routes and the proposed balancing dam.



LEGEND

- Contours
- Secondary Roads
- Nwamitwa Pipework
- Nwamitwa Site Raw Water Pipeline
- Proposed Dam Wall
- Proposed Nwamitwa Dam
- Villages
- Municipality Boundaries

PATH: s:/projects/H401775/mxd/Report/Bulk_../bulk_81.mxd

SCALE: 0 0.05 0.1 Km
1:3,000

PROJECTION INFORMATION:

COORDINATE SYSTEM:	Transverse Mercator
PROJECTION NAME:	TM 31
DATUM:	D_WGS_1984
SPHEROID:	WGS_1984
CENTRAL MERIDIAN:	31

CONSULTANT: aurecon

CLIENT: water affairs
Department: Water Affairs
REPUBLIC OF SOUTH AFRICA

TITLES:

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT

Raw Water Pipeline Route and Balancing Dam

FIGURE NO.: **8.1**

8.1.2 Identification of potential pipeline routes and location of proposed balancing dam

The main criteria in identifying a suitable pipeline route is that the invert level of the pipeline must remain below a level of 464 m to enable flow to gravitate to the proposed second balancing dam.

The pipeline route would become very long if the 465 m or 466 m contour lines are followed. It would thus be more economical to select the shortest route between the Nwamitwa Dam and the existing balancing dam and increase the excavation depth for short sections of the pipeline, than installing a much longer pipeline (i.e. at least another 250 m longer).

The location of the proposed balancing dam is dictated by (a) siting it within the existing boundary of the WTW, (b) the full supply level of the dam (i.e. 465 m to 467 m), (c) the shortest possible pipeline lengths to tie in with the other infrastructure, and (d) by designing an overflow from the balancing dam back to the river. The preferred position, based on the above criteria, is shown in **Figure 8.1**.

8.1.3 Water demand

The average annual daily demands (AADD) for the 2008, 2012 and 2027 scenarios are 219 ℓ/s, 262 ℓ/s and 350 ℓ/s, respectively. A peak week factor of 1,5 was applied to the AADD.

8.2 OPTIMISATION OF INFRASTRUCTURE COMPONENTS

8.2.1 Pipeline diameters

Table 8.1 shows the hydraulic capacity between Nwamitwa Dam and the existing balancing dam for different pipeline diameters and differential pressures (i.e. difference in water level) under gravity conditions.

Table 8.1 Hydraulic capacity under gravity conditions

Available pressure (m)	Hydraulic capacity (ℓ/s)				
	400 mm dia	450 mm dia	500 mm dia	600 mm dia	700 mm dia
1	119	162	214	345	518
2	173	235	311	502	753

Available pressure (m)	Hydraulic capacity (ℓ/s)				
	400 mm dia	**450 mm dia**	**500 mm dia**	**600 mm dia**	**700 mm dia**
3	215	293	387	625	937
4	251	342	452	730	1095
5	283	386	510	823	1235

The 2008 and 2027 peak week demands are 328 ℓ/s and 525 ℓ/s, respectively. It is evident from **Table 8.1** that a 450 mm diameter pipeline would be able to meet the 2008 demand only when the Nwamitwa Dam is at a level of 478 m or higher. A 600 mm diameter pipeline would be able to meet the 2008 demand with 1 m available pressure and would supply the 2027 demand with 2,2 m available pressure.

It is recommended that a 600 mm diameter pipeline be installed from the Nwamitwa Dam to the existing and proposed balancing dams. Water would be fed under gravity conditions to the proposed balancing dam when the water level in Nwamitwa Dam drops to below 474 m. The hydraulic capacity to the proposed balancing dam would be similar to that shown in **Table 8.1**, as the pipeline lengths are similar, as well as the available pressure.

The rising main between the proposed balancing dam and the existing balancing dam is only 200 m and pipe friction, even at high velocities, would not be significant. If a pumping velocity of 2,0 m/s is accepted, a 600 mm diameter rising main would be required to pump the 2027 demand of 525 ℓ/s. The pipe friction loss would be approximately 1 m, based on a Hazen-Williams friction coefficient of 130. The total manometric pumping head would thus be 10 m.

8.2.2 Balancing dam

It is proposed that the balancing dam be sized for 2 hours balancing capacity to prevent frequent stopping and starting of the pumps. A balancing capacity of 3 780 m^3 would thus be required for a peak demand of 525 ℓ/s. Based on a depth of 2 m, the surface area would be approximately 45 m x 45 m.

8.2.3 Pump sizing

It was noted in **Section 8.2.1** that the pump duty would be 525 ℓ/s at a total head of 10 m, based on a 600 mm diameter rising main. The initial pump duty would be 328 ℓ/s at a total head of 9,4 m.

Figure 8.2 shows the characteristic curve for a 600 mm diameter rising main, based on a Hazen-Williams coefficient of 130, as well as pump curves of a KSB ETA 250-29 pump, fitted with 290 mm impellers, and operating at 1 450 rpm.

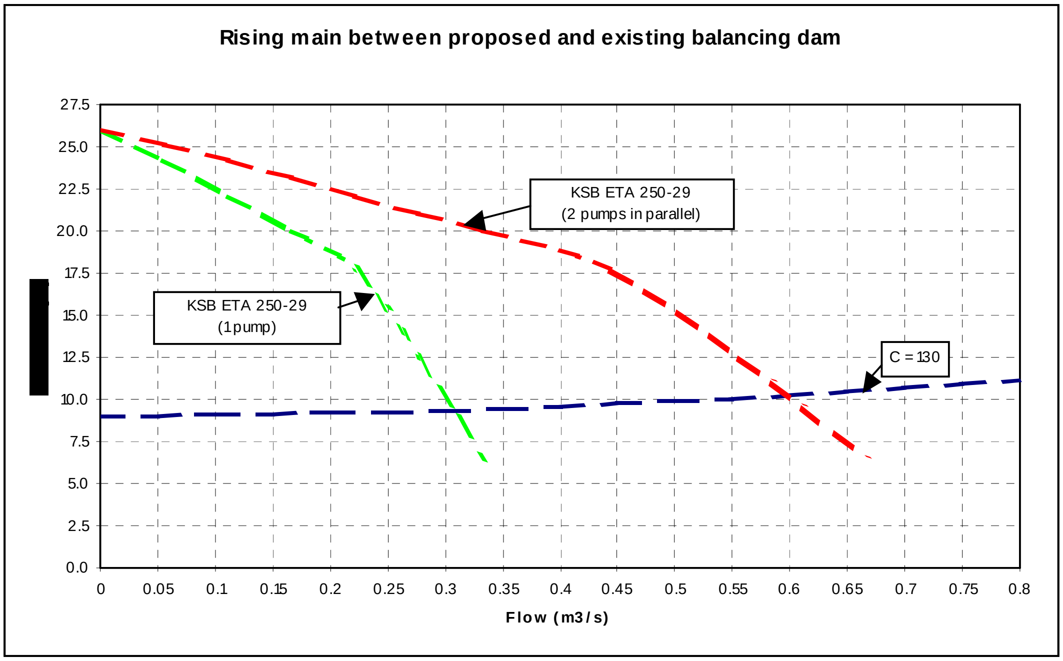


Figure 8.2 Characteristic curves for 600 mm pipeline with KSB ETA 250-29 pump curves (290 mm impeller)

It is evident from **Figure 8.2** that one pump would be able to deliver 310 ℓ/s, thereby almost meeting the 2008 demand of 328 ℓ/s. Two pumps in parallel would deliver 595 ℓ/s, which would meet the 2027 demand of 525 ℓ/s. It would therefore be possible to initially install two pumps (one duty, one standby) and later install a third pump (i.e. two duty, one standby) to meet the increase in demand.

8.3 PRELIMINARY PUMP STATION LAYOUT

The preliminary layout of the proposed raw water pump station is contained in **Appendix G** of this Report.

9. GROUNDWATER UTILISATION

A large number of villages in the supply area are reliant on groundwater. Many of the boreholes, however, deliver water of poor quality and require treatment before use. Blending poor borehole water with good quality water from surface water sources to dilute the high concentrations of solutes is one method of utilising the existing groundwater supply which was investigated.

The following groundwater use scenarios were investigated:

- Utilisation of existing groundwater supply by means of blending
- Utilisation of all existing groundwater supply by means of treatment
- Utilisation of all Class 1 existing groundwater supply
- Utilisation of future groundwater supply by means of blending
- Full groundwater utilisation

9.1 FULL UTILISATION OF EXISTING GROUNDWATER SUPPLY BY MEANS OF BLENDING

This scenario involves the use of all available groundwater in each village. Blending with treated water from the dam was used where groundwater was of insufficient quality to be used on its own.

As can be seen from **Table 9.1**, in 2027 the total demand from the proposed Nwamitwa Dam can be decreased by 16%. The largest decrease can be realised in the Giyani and Lower Molototsi and Worcester/Mothobeki regions, since the majority of these regions are currently reliant on groundwater resources.

Table 9.1 Dam demand decrease by blending with groundwater

		Full Water Demand (kℓ/d AADD)	Groundwater used (kℓ/d)	Demand from Dam (kℓ/d AADD)	Decrease in Demand from Dam (%)
2007	Letaba / Ritavi System	10 158	2 131	8 027	21%
	Thapane System	5 933	592	5 341	10%
	Lower Molototsi and Worcester/Mothobeki System	3 846	845	3 001	22%
	Giyani System	3 395	827	2 568	24%
	TOTAL	**23 332**	**4 396**	**18 936**	**19%**
2012	Letaba / Ritavi System	11 751	2 231	9 520	19%
	Thapane System	7 078	593	6 485	8%
	Lower Molototsi and Worcester/Mothobeki System	4 259	918	3 341	22%
	Giyani System	4 016	970	3 046	24%
	TOTAL	27 104	**4 713**	**22 391**	**17%**
2027	Letaba / Ritavi System	14 256	2 329	11 927	16%
	Thapane System	9 007	595	8 412	7%
	Lower Molototsi and Worcester/Mothobeki System	4 908	1 036	3 872	21%
	Giyani System	6 491	1 547	4 944	24%
	TOTAL	**34 662**	**5 508**	**29 154**	**16%**

9.2 UTILISATION OF ALL EXISTING GROUNDWATER SUPPLY BY MEANS OF TREATMENT

This scenario involves the assumption that all poor quality groundwater is chemically treated to produce a minimum of a Class I. All nitrate contaminated boreholes are also rehabilitated and fitted with sanitary seals. In other words, no blending water from the dam was required. This scenario gives an idea of the quantity of groundwater that is available regardless of quality, and so presents the most favourable situation from a water resources point of view. Note that no estimates regarding the cost of this chemical treatment are made.

Table 9.2 shows in 2027, 28% of the municipal water demand can be met from groundwater resources. In the outer reaches of the system up to 55% of the demand can be met from current boreholes.

Table 9.2 Dam demand decrease by treating all poor groundwater

		Full Water Demand (kℓ/d AADD)	Groundwater used (kℓ/d)	Demand from Dam (kℓ/d AADD)	Decrease in Demand from Dam (%)
2007	Letaba / Ritavi System	10 158	3 025	7 133	30%
	Thapane System	5 933	688	5 245	12%
	Lower Molototsi and Worcester/Mothobeki System	3 846	2 399	1 447	62%
	Giyani System	3 395	2 755	640	81%
	TOTAL	**23 332**	**8 867**	14 465	**38%**
2012	Letaba / Ritavi System	11 751	3 143	8 608	27%
	Thapane System	7 078	689	6 389	10%
	Lower Molototsi and Worcester/Mothobeki System	4 259	2 528	1 731	59%
	Giyani System	4 016	3 199	817	80%
	TOTAL	**27 104**	**9 559**	**17 545**	**35%**
2027	Letaba / Ritavi System	14 256	3 199	11 057	22%
	Thapane System	9 007	689	8 318	8%
	Lower Molototsi and Worcester/Mothobeki System	4 908	2 693	2 215	55%
	Giyani System	6 491	3 254	3 237	50%
	TOTAL	**34 662**	**9 835**	24 827	**28%**

9.3 UTILISATION OF ALL CLASS 1 EXISTING GROUNDWATER SUPPLY

This scenario assumes that only good quality borehole water (above a Class I) is used. All the other groundwater is excluded. This therefore gives an idea of the quality of the groundwater that is available in the system. As can be seen from **Table 9.3**, only 7% of the demand can be supplied by good quality groundwater. Most of this is found in the south-western regions near the dam, namely the Thapane and Letaba systems. No groundwater above a Class I exists in the north-eastern part of the study area. It is also evident that the groundwater in the north-eastern regions have poor water quality.

Table 9.3 Dam demand decrease by excluding all poor groundwater

		Full Water Demand (kℓ/d AADD)	Groundwater used (kℓ/d)	Demand from Dam (kℓ/d AADD)	Decrease in Demand from Dam (%)
2007	Letaba / Ritavi System	10 158	1 638	8 520	16%
	Thapane System	5 933	580	5 353	10%
	Lower Molototsi and Worcester/Mothobeki System	3 846	243	3 603	6%
	Giyani System	3 395	0	3 395	0%
	TOTAL	**23 332**	**2 462**	**20 870**	**11%**
2012	Letaba / Ritavi System	11 751	1 678	10 073	14%
	Thapane System	7 078	580	6 498	8%
	Lower Molototsi and Worcester/Mothobeki System	4 259	256	4 003	6%
	Giyani System	4 016	0	4 016	0%
	TOTAL	**27 104**	**2 514**	**24 590**	**9%**
2027	Letaba / Ritavi System	14 256	1 678	12 578	12%
	Thapane System	9 007	580	8 427	6%
	Lower Molototsi and Worcester/Mothobeki System	4 908	281	4 627	6%
	Giyani System	6 491	0	6 491	0%
	TOTAL	**34 662**	**2 539**	**32 123**	**7%**

9.4 UTILISATION OF FUTURE GROUNDWATER SUPPLY BY MEANS OF BLENDING

The groundwater assessment (DWA, 2010b), undertaken for the GLeWaP Study, presented a list of possible locations where each individual village could look for future groundwater wellfields. These locations were selected over shear zones or other geological groundwater features but the overriding influence in their siting was that they had to be close to the village they were meant to supply. Because of this, the possible future wellfields were often located in low groundwater potential areas, in terms of yield, quality and recharge. Any new proposed wellfield in a low potential zone was excluded and only high and moderate potential zones were considered. The desktop groundwater report for the logical supply area is contained in **Appendix I** of this report.

In order to further the analysis, a quality class for each new wellfield had to be assumed. This was done by observing the quality of nearby existing boreholes and choosing a representative quality class for the new boreholes. Each village was then again analysed as to whether or not it could use more groundwater of the chosen quality class, again assuming the previous blending ratios.

Where more groundwater from feasible wellfields could be used to decrease the demand from the dam, the number and possible location of these boreholes was determined. An overall cost was then estimated by assuming R100,000.00 per new borehole and R120.00 per meter of associated pipeline. Wellfields with too high a cost were disregarded.

Most of the new proposed wellfields are located in the north-eastern part of the study area. As can be seen from **Table 9.4**, in 2027 19% of the demand can be obtained from groundwater (compared to 16% of the demand as detailed in **Section 9.1** of this report). The total cost in abstracting a further 1 092 kℓ/d is estimated at R7.8 million, which equates to roughly R19.50 per cubic meter.

Table 9.4 Dam demand decrease by proposing future wellfields

		Full Water Demand (kℓ/d AADD)	Groundwater used (kℓ/d)	Demand from Dam (kℓ/d AADD)	Decrease in Demand from Dam (%)
2007	Letaba / Ritavi System	10 158	2 486	7 672	24%
	Thapane System	5 933	673	5 260	11%
	Lower Molototsi and Worcester/Mothobeki System	3 846	1 126	2 720	29%
	Giyani System	3 395	827	2 568	24%
	TOTAL	**23 332**	**5 113**	**18 219**	**22%**
2012	Letaba / Ritavi System	11 751	2 685	9 066	23%
	Thapane System	7 078	685	6 393	10%
	Lower Molototsi and Worcester/Mothobeki System	4 259	1 241	3 018	29%
	Giyani System	4 016	970	3 046	24%
	TOTAL	**27 104**	**5 580**	**21 524**	**21%**
2027	Letaba / Ritavi System	14 256	2 931	11 325	21%
	Thapane System	9 007	700	8 307	8%
	Lower Molototsi and Worcester/Mothobeki System	4 908	1 421	3 487	29%
	Giyani System	6 491	1 547	4 944	24%
	TOTAL	**34 662**	**6 599**	**28 063**	**19%**

9.5 FULL GROUNDWATER UTILISATION

The Ground Report (DWA, 2010b) recommended a possible strategy for supplying the region's water demand primarily by groundwater. It was suggested that the vast majority of the villages situated furthest from the dam be supplied exclusively with groundwater. Furthermore, any village lying close to a geological feature would draw its water from this feature. Only villages situated close to the proposed Nwamitwa Dam without geological features were supplied from the dam. Any current or future boreholes delivering poor quality water would need treatment to bring elevated concentrations of minerals down to an acceptable level. The results of this scenario are shown in **Table 9.5**.

Table 9.5 also shows that effectively, the entire water demand for the outlying regions is being met by groundwater and for the region as a whole the demand from the dam can be decreased by 57% for 2027. For this to be realised, a total of 438 new boreholes need to be installed. Together with a rough estimate of associated pipework, the cost would amount to R175.2 million. Note that this value does not include any treatment costs.

Table 9.5 Dam demand decrease by KLM recommendations

		Full Water Demand (kℓ/d AADD)	Groundwater used (kℓ/d)	Demand from Dam (kℓ/d AADD)	Decrease in Demand from Dam (%)
2007	Letaba / Ritavi System	10 158	5 154	5 004	51%
	Thapane System	5 933	1 508	4 425	25%
	Lower Molototsi and Worcester/Mothobeki System	3 846	3 845	1	100%
	Giyani System	3 395	3 395	0	100%
	TOTAL	**23 332**	**13 903**	**9 429**	**60%**
2012	Letaba / Ritavi System	11 751	5 757	5 994	49%
	Thapane System	7 078	1 682	5 396	24%
	Lower Molototsi and Worcester/Mothobeki System	4 259	4 256	3	100%
	Giyani System	4 016	4 016	0	100%
	TOTAL	**27 104**	**15 712**	**11 392**	**58%**
2027	Letaba / Ritavi System	14 256	6 565	7 691	46%
	Thapane System	9 007	1 954	7 053	22%
	Lower Molototsi and Worcester/Mothobeki System	4 908	4 907	1	100%
	Giyani System	6 491	6 462	29	100%
	TOTAL	**34 662**	**19 888**	**14 774**	**57%**

9.6 INTEGRATION OF FUTURE GROUNDWATER SUPPLIES INTO PROPOSED REGIONAL BULK WATER SUPPLY INFRASTRUCTURE

It is envisaged that groundwater obtained from a wellfiled in the Worcester/Molototsi system could be either taken to command reservoir C or D, or to a regional bulk water supply reservoir where the groundwater can be blended with better quality water from other source. Supplies from a wellfield developed in the Letaba/Ritavi supply area should be conveyed to either command reservoir A or B or to Runnymede regional bulk water supply Reservoir.

Groundwater sources can meet a portion of the AADD. The proposed regional bulk water supply systems would then supply the balance of the AADD, as well as the peak week water requirements. By utilising groundwater conjunctively with water from the proposed Nwamitwa Dam, it would be possible to:

- delay future extensions to the Nkambako WTW;
- delay the need for increased conveyance capacity to the proposed Command Reservoirs from Nkambako WTW (provided the yield of proposed Nwamitwa Dam is sufficient to allow for this possibility); and
- delay supplying water outside the logical supply area, such as to meet the future shortfall in the Mojadji system.

Command reservoir A and B and the Runnymede Reservoir are all located at an elevation of approximately 600 masl. The abovementioned system of reservoirs can also be gravity fed from the proposed command reservoir C situated north-west of Hlohlokwe at an elevation of 635 masl. Command reservoir D (elevation 550 masl) could also be gravity fed from command reservoir A or from command reservoir C. The planning of any future ground water scheme should take cognisance of the abovementioned flexibility which exists within the command reservoirs.

10. NWAMITWA RWS: CONCEPTUAL MASTER PLAN

In parallel with the GLeWaP Study, DWA appointed EVN Africa (EVN) to undertake a bulk water supply planning assignment for the area surrounding the proposed Nwamitwa Dam. In order to ensure integration between the two studies, EVN utilised the services of Aurecon to develop a conceptual master plan for the bulk distribution system. The conceptual master plan integrated the planning of the GLeWaP Regional Bulk Water Supply Infrastructure with the planning of the "Connector" Bulk Water Supply Infrastructure. The “connector” bulk water supply infrastructure links the command reservoirs identified in the GLeWaP Study with the water reticulation infrastructure in each settlement area. The Nwamitwa RWS Conceptual Master Plan Report is contained in **Appendix J** of this Report.

The analysis of the Letaba/Ritavi System, the Thapane System and the Worcester/Molototsi systems was undertaken using the Epanet model (free software provided by the US Environmental Protection Agency for the analysis of water distribution models). Epanet allows for a dynamic time simulation of reservoir levels which makes it ideal for this type of analysis, since it is able to monitor the behaviour of the reticulation system over a specified time period.

The systems were analysed independently to avoid overloading the application. An Epanet model of the existing system was set up initially and incrementally added to in order to be able to develop a model with bulk connector infrastructure covering the entire study area. The models were run for a peak week demand (i.e.168 hours) scenario, as this would represent the worst case in terms of the sizing of the proposed infrastructure. Since the ultimate goal is to provide infrastructure that will cater for demands up to the year 2027, 2027 demands were used in the hydraulic analysis.

The GLeWAP 2027 High Level Service Scenario water demand figures, received from EVN Africa Consulting Engineers, were used to determine the 2027 infrastructure requirements. The water demand figures for the all villages in each system are given in **Appendix A**. The High Level Service Scenario was chosen as the basis upon which to design the future infrastructure requirements as this represents the Water Service Authorities ultimate goal of providing water to each household as opposed to the current system of communal stand pipes.

The timing and phasing of both the regional bulk water supply infrastructure and the connector bulk water supply infrastructure is described in more detail in **Section 12** of this Report.

11. COST ESTIMATE

The cost estimate of the various components of the Regional Bulk Water Supply Infrastructure are described in detail in Section 6 of this report and are summarised in **Table 11.1**.

Table 11.1 Cost estimate of the various components of the Regional Bulk Water Supply Infrastructure

Scheme	Component	Cost Estimate (excluding VAT) (Note 1)
Nkambako WTW to Serolorolo Reservoir (Command Reservoir A)	Pump station, 450 mm diameter pipeline and upgrading of existing 315 m diameter Xihoko pipeline	R 37 million
Nkambako WTW to Babanana Reservoir (Command Reservoir B)	Pump station and 450 mm diameter pipeline	R 27 million
Serolorolo Reservoir to Command Reservoir C	Pump Station and 350 mm diameter pipeline	R 17 million
Command Reservoir C	5 Ml Reservoir	R 5 million
Serolorolo Reservoir to Command Reservoir D	450 mm diameter pipeline	R 24 million
Command Reservoir D	5 Ml Reservoir	R 5 million
Nkambako WTW	For an increase in capacity from 12 Ml/d to 45 Ml/d.	R 198 million
	TOTAL	R 313 million

Note 1: Costs include contingencies and professional fees. Costs have been escalated to reflect 2009 prices.

12. TIMING AND PHASING OF PROPOSED INFRASTRUCTURE

It is evident that all three water supply systems in the area currently receive an inadequate supply of water. All the proposed infrastructure components will be required to satisfy the specified level of service at the planning horizon of 2027. Because of the lack of usage metering and effective water conservation and demand management, there is uncertainty regarding current and the projected future water requirements. Therefore the implementation of the bulk connector infrastructure should proceed with caution. It is believed that there is an immediate need to implement certain components of the new bulk regional infrastructure as proposed in this report.

The proposed timing and phasing of the bulk water supply infrastructure (both Regional and Connector Infrastructure) is based on the following considerations:

1) The need to utilise existing unutilised bulk water supply infrastructure.

2) The need to provide reliable water services to area which currently receive no potable water.

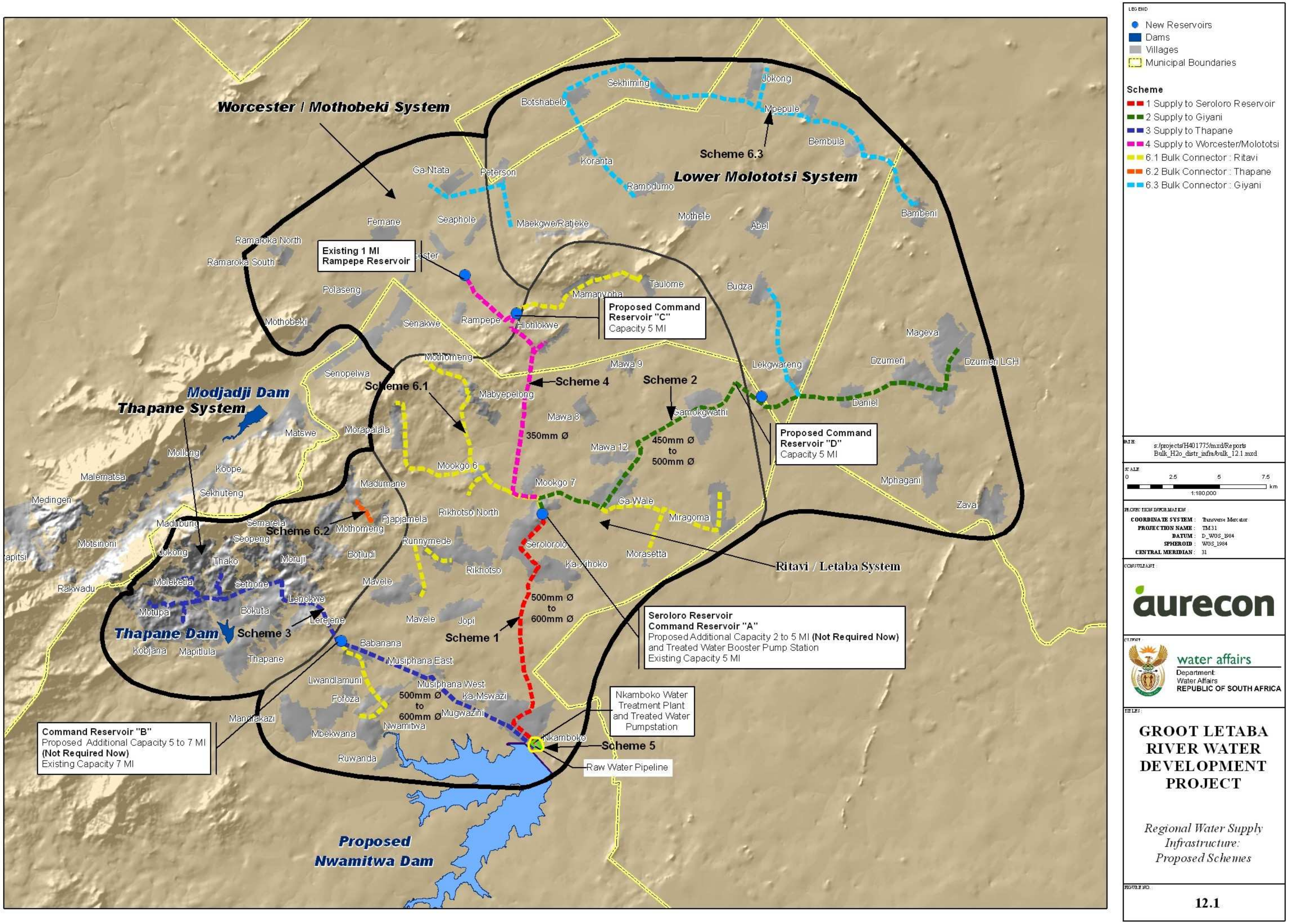
3) The need to augment water supplies to areas which currently experience water shortages and water rationing.

4) The need to expand the water reticulation network to all settlements and villages.

A number of logical schemes have been conceptualized and are presented below. Whilst the schemes are presented as individual stand alone schemes, it is important to note that the individual schemes operate as part of a bigger system and therefore should not be viewed in isolation. **Figure 12.1** graphically illustrates the regional and connector bulk water supply schemes which were conceptualised.

12.1 SCHEME 1: SUPPLY TO THE EXISTING 5 Mℓ SEROLOROLO RESERVOIR

Current Situation: Currently the 5 Mℓ Reservoir at Serolorolo does not receive any treated water from Nkambako WTW. The designated supply zone of Serolorolo Reservoir therefore receives limited water. Currently there is no water in Mookgo 7, Ga-Wale, Mawa 12, Mawa 8, Mawa 9, Mawa 12, Gamokgwathi and Miragoma despite having supply pipelines.



LEGEND
New Reservoirs
Dams
Villages
Municipal Boundaries
Scheme
1 Supply to Seroloro Reservoir
2 Supply to Giyani
3 Supply to Thapane
4 Supply to Worcester/Molototsi
6.1 Bulk Connector : Ritavi
6.2 Bulk Connector : Thapane
6.3 Bulk Connector : Giyani
Worcester / Mothobeki System
Lower Molototsi System
Thapane System
Ritavi / Letaba System
Modjadji Dam
Thapane Dam
Proposed Nwamitwa Dam
Scheme 1
Scheme 2
Scheme 3
Scheme 4
Scheme 5
Scheme 6.1
Scheme 6.2
Scheme 6.3
Existing 1 Ml Rampepe Reservoir
Proposed Command Reservoir "C" Capacity 5 Ml
Proposed Command Reservoir "D" Capacity 5 Ml
Seroloro Reservoir Command Reservoir "A" Proposed Additional Capacity 2 to 5 Ml (Not Required Now) and Treated Water Booster Pump Station Existing Capacity 5 Ml
Command Reservoir "B" Proposed Additional Capacity 5 to 7 Ml (Not Required Now) Existing Capacity 7 Ml
Nkamboko Water Treatment Plant and Treated Water Pumpstation
Raw Water Pipeline
350mm Ø
450mm Ø to 500mm Ø
500mm Ø to 600mm Ø
500mm Ø to 600mm Ø
COORDINATE SYSTEM : Transverse Mercator
PROJECTION NAME : TM31
DATUM : D_WGS_1984
SPHEROID : WGS_1984
CENTRAL MERIDIAN : 31
1:180,000
aurecon
water affairs
Department: Water Affairs REPUBLIC OF SOUTH AFRICA
GROOT LETABA RIVER WATER DEVELOPMENT PROJECT
Regional Water Supply Infrastructure: Proposed Schemes
12.1

Proposed Scheme

It is imperative that the design parameters of the newly laid 350 mm diameter pipeline between Nkambako WTW and the 5 Mℓ Reservoir at Serolorolo be confirmed (i.e. correct wall thickness to withstand negative pressures and water hammer). Should the design parameters satisfy the design criteria proposed in the GLeWaP Report, then the existing 350 mm diameter could be used to supply Serolorolo from Nkambako WTW. The proposed 500 mm diameter regional bulk water supply pipeline proposed in the Master Plan for the Ritavi/Letaba, Thapane and Worcester/Molototsi Systems could be downsized accordingly and implemented when the growth in future water requirement necessitated its implementation. It is anticipated that the existing pumps at Nkambako will be inadequate to pump water to Babanana, Runnymede and to Serolorolo. It is proposed that new pumps be installed at Nkambako Pump Station to pump water directly to the existing 5 Mℓ reservoir at Serolorolo. The booster pump station constructed on the new 350 mm diameter pipeline would then become redundant. A visual inspection showed that the existing pipeline from the 5 Mℓ Serolorolo Reservoir to Gamokgwathi was damaged at one of the river crossings and needs to be repaired. The cost estimate below is based on a new 500 mm diameter pipeline being constructed between Nkambako WTW and the 5 Mℓ Reservoir at Serolorolo. **Table 12.1** gives the summary of costs for Scheme 1.

Table 12.1 Summary of costs for Scheme 1

Component	Description	Estimated cost (Rand)
Pipeline	1 200 m, Class 9 PVC-U	R 1 500 000
Pump station	Two KSB WKLn 125/3 pumpsets, pipework, electrical works and civil building	R 2 500 000
Pressure relief valve	-	R 50 000
Total cost estimate (Rand) to ensure operation of existing 350 mm diameter pipeline to Serolorolo		**R 4 050 000**
New pipeline and pump station	450 mm diameter	R 24 000 000
TOTAL COST (pump stations and pipelines only), excluding Professional Fees, Contingencies and VAT		**R 28 050 000**
TOTAL COST (Pump stations and pipelines only). including Professional Fees, Contingencies and VAT		**Approx R 37 million**

12.2 SCHEME 2: SUPPLY TO GIYANI

Current Situation

Greater Giyani sub-system is situated to the east of the Letaba system. The scheme is fed from Giyani WTW which draws raw water from Middle Letaba and Nsami Dams, and from a weir near Zava on the Groot Letaba River. Due to all the connections and high water requirements on the bulk reticulation supply line from Kremertart, the lower areas beyond Dzumeri do not receive any water supply in spite of the existing pipeline infrastructure. Most of the settlements downstream of Dzumeri are now relying on groundwater supply. The overall quality of the existing groundwater supply to the area is a DWAF Class III water which is classified as an unacceptable water quality.

Proposed Scheme

This scheme will entail laying a new gravity pipeline from the existing 5 Mℓ Reservoir at Serolorolo to a proposed 5 Mℓ Reservoir sited to the east of Gamokgwathi. A further gravity pipeline will have to be constructed from the new 5 Mℓ reservoir to Dzumeri in Giyani. It is proposed that the existing 160 mm diameter pipeline laid between the existing 5 Mℓ reservoir at Serolorolo and Gamokgwathi be extended to the proposed 5 Mℓ reservoir and be utilised until the conveyance capacity of the existing pipeline is exceeded, whereafter the proposed 450 mm gravity pipeline would have to be implemented. The cost estimate provided below is based on the proposed 450 mm diameter pipeline being implemented. **Table 12.2** gives the summary of costs for Scheme 2.

Table 12.2 Summary of costs for Scheme 2

Scheme 2: Supply to Giyani		
Infrastructure Requirements	**Cost**	**Comments**
New 450 mm diameter pipeline from Serolorolo Reservoir (Reservoir A) to Command Reservoir D	R 24.0	Could utilise existing 160 mm diameter pipeline to Gamokgwathi in interim
Command Reservoir D	R 4.6	Needed to provide balancing storage
Pipeline from Command Reservoir D to Giyani	R 14.5	Pipelines required to connect Reservoir D to Giyani
Proposed Reticulation Reservoirs	R 13.5	Reticulation Reservoirs required to provide balancing storage
TOTAL	**R 57**	

12.3 SCHEME 3: SUPPLY TO THAPANE

Current Situation

The Thapane system is bound by the Lower Modjadji system in the north and the Letaba system in the east. The system serves villages which are in relatively close proximity to each other with the exception of Madumane and Pfapfamela.

The scheme is currently under the jurisdiction of Greater Tzaneen Municipality. The scheme is supplied by Thapane Dam, which has a reported yield of 1.5 Mm^3/a. Raw water is pumped to Thapane WTW using two submersible pumps with a total capacity of 50 ℓ/s. Thapane WTW has a capacity to supply 4 100 kℓ/d.

Mopye booster pump station consists of two pump sets (one duty and one standby). The pump station feeds two service reservoirs; one at Motupa and the other at Mopye. The operation is such that they pump to one reservoir at a time. Currently, the reservoir at Mopye is only supplied until half-filled as a way of water rationing. When half-filled, it takes about six hours for the reservoir to empty. Villagers do therefore not receive a continuous supply of water throughout the day. Some villages go for three days without running water. This is as a result of inadequate water resources and inadequate infrastructure. Major parts of Relela, Jokong and Mothomeng do not have water supply, primarily due to lack of infrastructure, but also due to inadequate pressure in the case of Mothomeng.

Proposed Scheme

The proposed Scheme will supplement the supply to the Thapane area from the proposed Nwamitwa Dam. The Scheme entails installing additional pumps at Nkambako WTW and ultimately laying a new rising main from Nkambako WTW to the existing 7 Mℓ Babanana Reservoir, when the capacity of the existing pipeline is exceeded. A new pump station and 400 mm rising main would have to be constructed from Babanana Reservoir to a proposed 5 Mℓ reservoir at Mohlokong. From Mohlokong new gravity pipeline(s) would have to be constructed to be able to supply a greater part of the Thapane area. **Table 12.3** gives the summary of costs for Scheme 3.

Table 12.3 Summary of costs for Scheme 3

Scheme 3: Supply to Thapane		
Infrastructure Requirements	**Cost (R million)**	**Comments**
Pump Station : Nkambako WTW to Babanana Res	R 11	Requirement due to current insufficient pumping capacity
Pipeline from Nkambako WTW to the existing 5 Mℓ reservoir at Babanana	R 32.4	Existing pipeline could be utilised until conveyance capacity of existing pipeline is exceeded.
Pipeline: Babanana Reservoir to Mohlakong/Motupa/Marironi	R 20.34	
Pump Stations	R 5.66	
Reticulation Reservoirs	R 13.72	
TOTAL	**R 83.12**	

12.4 SCHEME 4: SUPPLY TO THE WORCESTER/MOTHOBEKI AND LOWER MOLOTOTSI SYSTEM

Current Situation

The Worcester/Molototsi system is under the jurisdiction of Mopani District Municipality. The villages in this system are widely spaced. A number of villages are connected to bulk reticulation infrastructure. The primary source of water is the Modjadji Dam, however, this supply is insufficient and the Worcester-Molototsi system is supplemented by groundwater supplies.

Based on the discussion with the operators of this system, a number of problems were identified. These are listed below:

- Supply from Modjadji WTW to Worcester/Molototsi system is erratic as focus of supply is mainly to Lower Modjadji sub-system.
- Peterson, Ga-Ntata, Koranta, Botshabelo, Sekhiming, Jokong and Bembula are currently not linked to the bulk supply system and are supplied by boreholes.
- Water from the boreholes is of poor quality and there have been reported cases of calcium deposition in pipes causing blockages.

Proposed Scheme

The proposed Scheme will supplement the supply to the Worcester/Molototsi system from the proposed Nwamitwa Dam (ultimately replace the existing supply from Mojdaji Dam). The Scheme entails constructing a rising main between Serolorolo Reservoir and a new 5 Mℓ Reservoir situated between Hlohlokwe and the existing Rampepe Reservoir. The proposed 5 Mℓ Reservoir would be linked to the existing Rampepe Reservoir by a new 400 mm diameter gravity pipeline. **Table 12.4** gives the summary of costs for Scheme 4.

Table 12.4 Summary of costs for Scheme 4

Scheme 4: Supply to Worcester-Molototsi		
Infrastructure Requirements	**Cost**	**Comments**
Pump Station: Booster Pump station at Serolorolo	R 2.7	
Pipeline Serolorolo Reservoir to Command Reservoir C	R 14.3	
Command Reservoir C	R 4.6	Needed to provide balancing storage
Pipeline: Reservoir C to Rampepe Reservoir	R 4.9	
TOTAL	**R 26.5**	

12.5 Scheme 5: Upgrading of Nkambako WTW

In order to meet the anticipated growth in future water requirements, the Nkambako WTW will ultimately have to be expanded to a capacity of approximately 45 Mℓ/d. This will enable the WTW to meet the 2027 growth in peak week water demand. **Table 12.5** gives the summary of costs for Scheme 5.

Table 12.5 Summary of costs for Scheme 5

Scheme 5: Upgrading Nkambako WTW		
Infrastructure Requirements	**Cost**	**Comments**
Water Treatment Works	R 198	Could be phased in increments dependent on the growth in water requirements
TOTAL	**R 198**	

12.6 Scheme 6: Bulk Connector Infrastructure

Scheme 6.1: Ritavi (Letaba) System

A number of settlements do not have a potable water supply and currently rely upon groundwater. The groundwater water quality varies from settlement to settlement and is largely dependent on the siting and location of the boreholes. The following settlements have been identified as requiring a potable water supply:

- Mothomeng
- Morapalala

- Mabyepelong
- Hlohlokwe
- Mamanyoha
- Taulome
- Morasetta
- Miragoma

With the necessary bulk connector infrastructure (pipelines, reservoirs and pump stations), the abovementioned settlements will be able to abstract water either under gravity or via pumping from the regional bulk water supply infrastructure and connector bulk water supply infrastructure proposed under this conceptual master plan. **Table 12.6** gives the summary of costs for Scheme 6.1.

Table 12.6 Summary of costs for Scheme 6.1

Scheme 6.1: Supply to Ritavi (Letaba)	
Infrastructure Requirements	**Cost**
Pump Stations	R 0.3
Pipelines	R 28.8
Reservoirs	R 35.0
TOTAL	R 64.8

Scheme 6.2: Thapane System

A limited number of settlements in the Thapane area would require additional bulk infrastructure to, as the required connector infrastructure has already been allowed for under Scheme 3: Supply to Thapane. The settlements which require additional infrastructure (over and above Scheme 3) are: Botludi, Mothomeng, Madumane and Pjapjamela plan. **Table 12.7** gives the summary of costs for Scheme 6.2.

Table 12.7 Summary of costs for Scheme 6.21

Scheme 6.2: Supply to Thapane	
Infrastructure Requirements	**Cost**
Pump Stations	R 1.92
Pipelines	R 1.6
Reservoirs	R 3.4
TOTAL	**R 6.92**

Scheme 6.3: Worcester/Molototsi System

A number of settlements in the Worcester/Molototsi system require additional infrastructure to cater for the proposed growth in water requirements. **Table 12.8** gives the summary of costs for Scheme 6.3.

Table 12.8 Summary of costs for Scheme 6.3

Scheme 6.3: Supply to Worcester/Molototsi System	
Infrastructure Requirements	**Cost**
Pipelines	R22.1
Reservoirs	R20.6
TOTAL	**R42.7**

13. CONCLUSIONS

From the study undertaken, it is evident that critical shortages of treated potable water exist in the Letaba, Thapane and Worcester/Molototsi systems. These water shortages can be attributed to insufficient water resources, the lack of bulk water infrastructure and incorrect pump type selection. In order to alleviate these shortages, it is imperative that the regional bulk water supply infrastructure as proposed in the recommendations of this report be implemented. It is important that the design of the regional bulk water supply infrastructure be integrated with the design of the bulk connector infrastructure in order to avoid unnecessary redundancies in the water supply system and to ensure that the most optimal design is obtained. There is uncertainty regarding the current and future water requirements in the area of supply of the proposed Nwamitwa Dam. It is therefore imperative that Mopani District Municipality ensure the metering and monitoring of all the proposed bulk water supply schemes. The expansion of the Nkambako WTW could be undertaken modularly as the water requirement increases in the future.

It is important to ensure that the recently constructed 355 mm Xihoko rising main is able to deliver water to the command reservoir at Serolorolo and that the Nkambako WTW is functioning at 12 Ml/d. Proposed modifications to this rising main have been made in this report and should be implemented as soon as possible. This will ensure that the existing bulk water infrastructure is fully utilised and certain villages that have not received potable water before will now be able to receive potable water.

Most of the good quality groundwater is found in the relatively wetter western part of the study area. The north-eastern part of the region, namely the villages in the Worcester/Molototsi system are being supplied by boreholes of Class III and IV, which is unacceptable for potable use. Groundwater could potentially supply a significant portion of the future water requirements in the logical supply area of the proposed Nwamitwa Dam, either through blending with potable supplies or by onsite treatment prior to conveying the treated water to the regional bulk water supply reservoirs. More detailed investigative studies have to be undertaken by the DWAF in order to determine the full potential of groundwater in the area.

14. RECOMMENDATIONS

14.1 REGIONAL BULK WATER SUPPLY INFRASTRUCTURE

The following recommendations are made regarding the implementation of the regional bulk water supply infrastructure:

a. The Regional Bulk Water Supply Infrastructure as proposed should be implemented.

b. The proposed timing and phasing of the bulk water supply infrastructure (both Regional and Connector Infrastructure) be based on the following considerations:

   1) The need to utilise existing bulk water supply infrastructure to maximum capacity
   2) The need to augment water supplies to areas which currently receive little or no potable water
   3) The need to augment water supplies to areas which currently experience water shortages and water rationing
   4) The need to expand the water reticulation network to all settlements and villages.

c. The Nkambako WTW shall be designed to cater for the expected changes in the raw water quality in the long term.

d. The following upgrades are recommended for the existing 355 mm Xihoko rising main:

   - Replace approximately 1 200 m of Class 6 PVC-U pipes with Class 9 pipes
   - Install two new pumps (i.e. one duty, one standby) at the WTW to feed the 355 mm rising main (i.e. the existing pumps are not suited for the required duty)
   - Construct a sump at the suction side of the booster pump station or install a pressure relief valve

e. Mopani District Municipality should implement a metering and monitoring system in order to ascertain the actual water consumption for domestic purposes and to establish how the water requirement changes with the implementation of the regional bulk water supply and connector bulk infrastructure. This will enable informed decisions to be taken about future infrastructure upgrades as well as the timing of the necessary increase in water treatment capacity.

f. The capacity of the Babanana Reservoir (command reservoir B) and the Serolorolo Reservoir (command reservoir A) should be increased when the future water requirements reach the stage that there is insufficient emergency and balancing storage in the respective supply areas.

g. Provision should be made for including water from a future regional groundwater supply system in the bulk infrastructure which stores and distributes treated water from surface water resources.

h. It is proposed that the regional bulk water supply infrastructure supplying the Worcester/Molototsi System be used to supplement the water requirement shortfall to the Modjadji system during off peak periods should it be required.

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