Mangaung Metropolitan Municipality

GARIEP DAM TO BLOEMFONTEIN BULK WATER AUGMENTATION SCHEME (GBWSS)

TECHNICAL FEASIBILITY STUDY REPORT

MAY 2015

Issued by:

Mangaung Metropolitan Municipality
PO Box 3704
Bloemfontein
9300
Tel: (051) 405 8911
Fax: (051) 405 8108
Attention: Mr Luvuyo Ntoyi

Compiled by:

BIGEN AFRICA Services (Pty) Ltd
Allan Cormack Street, The Innovation Hub, Pretoria
PO Box 29, Innovation Hub, 0087
Tel: +27(0)12 842 8700
Fax: +27(0)12 843 9000/9001
E-mail: pretoria@bigenafrica.com

Enquiries: Dr. JJ van der Walt; Mr P van Heerden; Mr P Cilliers

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Mangaung Metropolitan Municipality

GARIEP DAM
AUGMENTATION PROJECT (GAP)

TECHNICAL FEASIBILITY STUDY REPORT

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GLOSSARY/ACRONYMS

BFS	-	Bankable feasibility study
BOT	-	Build operate and transfer
BOOT	-	Build operate own and transfer
CBS	-	Cost Breakdown Structure
COGTA	-	Department of cooperative government and traditional affairs
CSI	-	Corporate social investment
DWA	-	Department of Water Affairs
DWS	-	Department of Water and Sanitation
ECA	-	Environmental Conservation Act
EIA	-	Environmental impact assessment
EPC	-	Engineer procure and construct
GAP	-	Gariep Bulk Water Augmentation Scheme
IDP	-	Integrated development plan
LRA	-	Labour relations Act
MMM	-	Mangaung Metropolitan Municipality
MTREF	-	Medium term revenue and expenditure framework
MSA	-	Municipal Structures Act / Municipal Systems Act
NEMA	-	National environmental management Act
NPV	-	Nett present value
OHSA	-	Occupational Health and Safety Act
PMBOK	-	Project Management Book of Knowledge
TFS	-	Technical feasibility study
WBS	-	Work breakdown structure
WCDM	-	Water conservation and water demand management
WSDP	-	Water services development plan
WSA	-	Water services authority / Water Services Act
WSP	-	Water services provider
WTW	-	Water treatment works
WULA	-	Water use license application
WwTW	-	Wastewater treatment works

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Mangaung Metropolitan Municipality

GARIEP DAM
AUGMENTATION PROJECT (GAP)

TECHNICAL FEASIBILITY STUDY REPORT

EXECUTIVE SUMMARY

1. EXECUTIVE SUMMARY

Mangaung Metropolitan Municipality had a population of about 750 000 people in 2011. About 95% of the population is supplied from bulk surface water systems operated by MMM and Bloem Water. Based on current water use, water use efficiency improvements, population growth and level of service improvements MMM is projected to run out of water very soon. In order to address this projected water shortage a water supply scheme was conceived referred to as the Gariep Bulk Water Augmentation Scheme (GAP).

The key questions addressed in this Technical Feasibility Study are:

- The necessity of the Gariep dam Augmentation Project
- The scope, schedule and costs requirements
- The funding, structuring, risks and statutory requirements
- Action to be conducted during Bankable Feasibility Stage

1.1. Business Need

In order to address the question of why the GAP is necessary, a number of aspects were considered. These included:

- A **regional reconciliation** of available and future water resources Mangaung Metropolitan Municipality (MMM) is **projecting water resource constraints** for planned new housing developments and improved levels of service. A new sustainable, reliable and affordable water source therefore needs to be developed to address Bloemfontein's water resource constraints in time. The **requirements for additional water** demand growth projected over the next 20 years was determined.
- After establishing the total water requirements it was necessary to optimise **current water resources** and supply systems in order to limit the additional water requirements. It was found that a number of **local water resources** were not optimally used and that these resources could be **optimised** through water conservation and water demand management (WCDM), internal water transfer and **water reuse** at the Maselspoort WTW. It is essential that the local resources be developed in parallel to GAP.
- A number of shortcomings were identified with the **resources and transfer systems linked to the Caledon** River. These challenges include siltation of the Welbedacht dam, complexity of water supply schemes, transfer losses and aging infrastructure. By increasing the supply from the Caledon system, the inherent risks associated with shortcomings are concentrated and other external sources were also explored.

- After assessing a range of alternative water resources the **Gariep dam** was found to be the most favourable from a resource and water supply perspective.

1.2. Strategic Importance

The primary purpose of the Gariep transfer scheme is to augment the existing water sources and water supply systems to the Greater Bloemfontein area for future growth in demand. The Gariep bulk water augmentation scheme aims to address the following national, provincial and local strategic objectives:

- Provide an additional source of reliable potable water to the Greater Bloemfontein area;
- Optimise local resources in order to contain cost of water;
- Provide relief to existing water supply systems currently operating close to its capacity;
- Support growing housing developments and formalization of informal settlements in the sub-region;
- Support improved levels of service to existing consumers in particular with a focus of removing VIPs;
- Support economic development and provide water services required for such developments.

1.3. Options Considered

The decision to pursue the Gariep transfer scheme was taken after considering the potential to expand and optimise the use of existing water resources. These include the Caledon and Modder river resources as well as the locally produced treated effluent. An integrated regional water balance incorporating optimisation of local water resources and WCDM was developed and this indicated a resource and infrastructure capacity deficit in the next few years. In addition to the local infrastructure upgrades required for local water use optimisation, various water resource operating rules were considered.

Various water supply options have been compared in terms of technical, financial and strategic aspects. The conclusion can be summarised as follows:

- Water Conservation and Water Demand Management (WCDM) is an **imperative** to maximise existing water resources.
- Local **water reuse** is an necessity as a means to maximise local resources and limit the importation of additional water sources.
- The further development of the Caledon transfer scheme is linked to fundamental siltation challenges and supply risks.
- The most reliable external water resource provides a direct route between Gariep dam and Bloemfontein was found to be the most economical transfer system.

1.4. Project Description and Scope

The GAP project comprises a bulk water transfer system transferring raw/potable water from Gariep dam to Bloemfontein. The infrastructure work packages related to the GAP include all aspects from raw water abstraction and pumping, potable water treatment, transfer and terminal storage and connection to Bloemfontein's reticulation system.

The current sustainable yield available to MMM is 89.4 Million m^3/annum (245 Ml/d). The yield of the system will be increased through local water reuse by approximately 18.2 Million m^3/annum to 107.6 Million m^3/annum. The projected average (peak) demand[1] for 2035 is 325 Ml/d (455 Ml/d) for a 1% growth scenario. The corresponding projected average (peak) demand for 2035 for a 2% growth scenario is 402 Ml/d (563 Ml/d). The total yield required for MMM therefore ranges between 118.7 and 146.8 Million m^3/annum depending on the growth scenario considered. Subtracting the yield of the current system requires a nett external transfer from the Gariep dam of between 41 and 69 Million m^3/annum. This translates to an average annual transfer rate between 112 and 189 Ml/d. In order to meet the 7 day peak demand a transfer rate of between 100 to 208 Ml/d are required for the 1% and 2% growth scenarios respectively.

A regional transfer system of the scale should be designed for a life expectancy of 75 years. A 95% transfer reliability was assumed. The ultimate transfer capacity can be delivered in two stages in order to delay CAPEX investment. Due to critical nature of the system, a 48 hour storage capacity was included in all intermediate and terminal reservoirs. The system was designed to transfer predominantly potable water in order to reduce transfer losses. Potable water treatment quality will comply with the latest SANS 241. As a result of the ongoing ESKOM supply issues an alternative power supply source was considered. The viability of this as an alternative power supply source is being evaluated.

1.5. Project Stakeholders

A number of key stakeholders are involved, impacted and affected by the GAP and include:

- National and provincial departments
- Parastatals
- Private stakeholders
- Land owners along pipeline corridor
- MMM consumers

1.6. Financial aspects

The key financial aspects considered during the Technical Feasibility Strategy (TFS) stage (still to be refined during the BFS) included the CAPEX estimates, OPEX estimates, potential cashflows, potential water tariffs and NPV estimates. These aspects need to be refined during the Bankable Feasibility Stage.

The total investment required for the GAP is estimated at R4 300 million if implemented as a single phase. The CAPEX can be delayed by implementing the scheme in two phases. The cost of the first 100 Ml/d phase is estimated at R3 600 million.

The operational cost (excluding financing cost) is currently estimated at R3.5/m^3. This includes variable costs for raw water abstraction (R0.2/ m^3), energy (R1.38/ m^3) and treatment (R0.5/m^3) and fixed cost for maintenance R 44 million per annum and personnel cost at R7 million per annum.

[1] *For the purpose of this study a 7 day peak demand peak factor of 1.4 was assumed and a design horizon of 20 years (2035) was assumed.*

1.7. Project Risks

The key project risks have been described in detail in the report. The highest risk items include Department of Water and Sanitation (DWS) and Bloem Water potential opposition to the project, inability to raise funding for project preparation and implementation, inability to secure adequate ESKOM power supply, inability to secure abstraction water use rights from Gariep dam, insufficient political support and delayed statutory approvals. Some of the risks can only be addressed during the subsequent BFS phase.

1.8. Project Execution

The GAP is currently planned to be developed in three distinct stages; The project preparation stage, the project procurement stage and the project implementation stage. The *project preparation stage* includes the aspects related to the setting up of project structures, the sourcing of project funding and the completion of the feasibility study phases. Key milestones include the following:

- Pre-feasibility study completed – November 2014
- PSP team for feasibility study phases assigned and appropriately structured – January 2015
- Technical feasibility study completed – May 2015
- Revise TFS and Commission BFS study team – June 2015
- Commission specialist investigations, site surveys and authority approvals – June 2015
- Project underwriter secured – October 2015
- Project structure agreed – November 2015
- Bankable feasibility study completed (with potential conditions precedent) – December 2016

The *procurement stage* involves the development of procurement documentation and identifies the preferred bidder. Milestones include:

- Procurement documentation completed – September 2015
- Pre-qualification completed – October 2015
- Closing of bid documents – December 2015
- Preferred bidder notice – January 2015

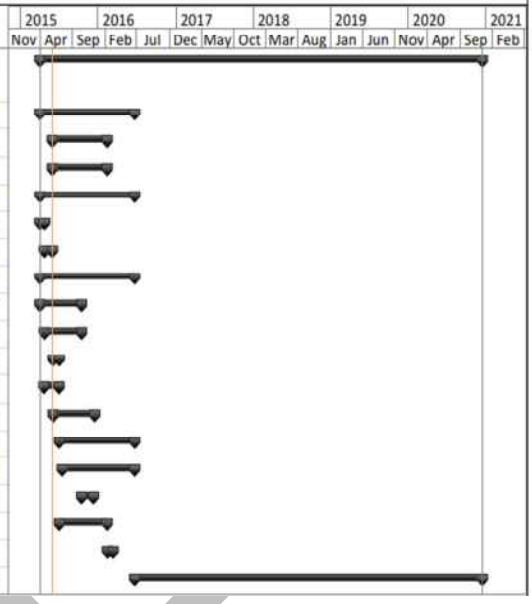
The *implementation stage* ensure that the contractor constructs, commissions, hands over (and in some case operate) the infrastructure. Milestones include:

- Notice to proceed with construction – January 2016
- Approval of project management plan – February 2016
- Approval of designs – April 2016
- Commissioning completed and delivery of first water – November 2019
- Trial period completed and hand over – February 2020

A high level Gant chart showing the project schedule is shown below:

MANGAUNG METRO MUNICIPALITY - GARIEP BULK WATER PIPELINE

ID	Task Name	Duration	Start	Finish
1	Mangaung Metro Municipality (MMM) Bulk Water Supply & Sanitation	1472 days	Wed 15-04-01	Tue 20-12-15
2	Programme Management	302 days	Wed 15-04-01	Tue 16-06-21
3	Key MileStones	169 days	Fri 15-05-29	Fri 16-02-12
4	*Feasibility Deliverables*	*169 days*	*Fri 15-05-29*	*Fri 16-02-12*
12	Feasibility	302 days	Wed 15-04-01	Tue 16-06-21
13	Initiation	16 days	Wed 15-04-01	Wed 15-04-22
15	Planning	25 days	Thu 15-04-23	Fri 15-05-29
19	Execution	302 days	Wed 15-04-01	Tue 16-06-21
20	Water & Sanitation Master Plan	136 days	Wed 15-04-01	Wed 15-10-14
30	Financial Model	120 days	Thu 15-04-23	Wed 15-10-14
37	Programme Execution Plan (PEP)	21 days	Mon 15-06-01	Tue 15-06-30
92	Technical Feasibility Study Report	48 days	Mon 15-04-20	Mon 15-06-29
159	Bankable Feasibility Study Report	137 days	Wed 15-06-03	Tue 15-12-15
185	Early Works & Statutory Approvals	240 days	Wed 15-07-01	Tue 16-06-21
197	Legal & Regulatory	230 days	Tue 15-07-14	Tue 16-06-21
214	Due Diligence Report	40 days	Thu 15-10-15	Wed 15-12-09
218	Assurance & Approvals	148 days	Wed 15-07-01	Fri 16-02-12
221	*Close-out*	*20 days*	*Mon 16-02-15*	*Fri 16-03-11*
223	External Gariep Bulk Water System Project	1170 days	Wed 16-06-22	Tue 20-12-15



1.9. Conclusions and Recommendations

The technical feasibility study demonstrated that the **GAP is a feasible project** with many socio-economic benefits to the region. The technical feasibility study also highlighted areas that require further refinement and development in order to ensure that the project is brought to financial close.

Based on the outcome of the TFS it is **recommended** that the Gariep bulk water supply scheme (GAP) be developed to a BFS level of detail. There are, however, still a number of key gaps that needs to addressed during the BFS. It is recommended that MMM budget and provide funding for the completion of the FS during the F2015/16 budget. The key issues that need to be confirmed during the BFS phase are summarised in Table 19.1.

The estimated cost to complete the Bankable Feasibility Study includes Technical, Project structuring, Financial, Funding, Legal and Statutory requirements is summarised in the table below.

	Cost estimate for Gariep Augmentation Project Bankable Feasibility Study	
1	Technical and Engineering Aspects	R 22 826 000
2	Procurement documentation	R 17 888 000
3	Specialist investigations and land use	R 6 000 000
4	Project Structuring Aspects	R 1 000 000
5	Financial modelling Aspects	R 2 500 000
6	Funding and structuring Aspects	R 5 750 000
7	Legal documentation Aspects	R 3 000 000
8	Statutory approval Aspects	R 1 800 000
	TOTAL	R 60 764 000

PART I – PROJECT INTRODUCTION AND BACKGROUND

2. INTRODUCTION

2.1. General

2.1.1. Current water supply status and identified local water source opportunities

The city of Bloemfontein (literally means 'fountain of flowers') was established during the late 1800s. At the time the city relied on ground water from the local fountains. The city gradually expanded and the nearby Modder River ('mud river') was developed as a supplementary water source. For this purpose a weir was constructed in the Modder River for short term storage. A water treatment plant, pumping station and a pipeline for transferring potable water to Bloemfontein was constructed at Maselspoort. The first phase of Maselspoort WTW was constructed around the early 1900's and over time the demand increased as Bloemfontein expanded. Maselspoort WTW was again expanded and upgraded around 1950 and again around 1970 to a nominal treatment capacity of about 100 Ml/d. During the same period two large towns were established in the upper catchment of the Modder River, i.e. Thaba Nchu and Botshabelo.

A new water source was developed in the 1970's from the Caledon River to supply the towns of Thaba Nchu and Botshabelo (via Rustfontein WTW) as well as the growing water demands of Bloemfontein (via Welbedacht WTW). Since the development of the Caledon river source, Bloemfontein continued to expand as the capital of the Free State province to the extent that peak water demand have on accoasions exceeded the treatment capacity of the WTW's supplying the greater MMM. Based on a regional reconciliation of available and future water sources Mangaung Metropolitan Municipality (MMM) is projecting water resource constraints for planned new housing developments and improved levels of service. A new sustainable, reliable and affordable water source and supply system had to be developed to address Bloemfontein's water resource constraints in time.

2.1.2. Water reuse potential as a means to augment MMM water sources

Approximately 180 Ml/d (65.7 Million m^3/annum) is currently abstracted (2014, MMM) from the Modder and Caledon river sources to supply Bloemfontein with a population of about 390 000 people[2]. The total MMM population is estimated at about of about 800 000 people[3]. A significant portion of this water ends up as return flows (in the form of treated effluent) in the Rhenosterspruit which joins the Modder river downstream of Maselspoort. Based on recent sewage catchment modelling this effectively transfers as much as 90 Ml/d of effluent from the Bloemfontein catchment into the Modder river. Bloemfontein is also currently at the point of exceeding its resource capacity and embarked on a local reconciliation study of available resources before committing to major augmentation transfer schemes. It was shown during this study that as much as 90 Ml/d can be intercepted from the Bloemspruit and North Eastern WwTW's and transferred to Mockes dam to be reused at Maselspoort WTW. The engineering design to upgrade Maselspoort[4] to a 140 Ml/d water reuse facility

[2] *Based on 2011 census data.*
[3] *Based on 2011 census data.*

[4] *The rated capacity of the new upgraded Maselspoort WTW is 140 Ml/d raw water treated. This will result in a potable water production of about 132 Ml/d if 6% treatment losses are assumed. It should be noted that without the process upgrade, water reuse cannot be effected*

is at an advanced stage (MMM, 2014c). The impact of water reuse is entrenched in the development of a regional water balance discussed later in the report. It should be noted that the increased potable water reuse will require some modifications to the internal bulk distribution system of Bloemfontein. This aspect is addressed in a separate internal bulk distribution report (MMM, 2015g)

2.1.3. Gariep bulk water augmentation scheme - an integral part of a regional water resource base

As mentioned earlier MMM is currently receiving water from three systems; an old water treatment works at Maselspoort (operated by MMM), Welbedacht WTW and Rustfontein WTW (both operated by Bloem Water). During the past few years a number of investigations were conducted on behalf of MMM in an effort to improve the water supply security and also to improve the understanding of how the water resources can be managed in an integrated and optimal manner. A number of key elements need to be considered in order to optimise the water resources available to MMM prior to determining the size and phasing of an external source such as the Gariep bulk water supply scheme;

- Firstly, the current supply **agreement** between Bloem Water and MMM is not considered to be a fair agreement and current attribute resource costs to MMM for which Bloem Water does not incur any costs. The agreement also puts a limit on the amount of water abstraction from the Modder river for no apparent reason. It is recommended that this agreement be changed to a cost plus arrangement and that any abstraction limits from Modder River be removed.
- Secondly, significant **water conservation and water demand management** opportunities exist in all three towns in MMM. The system input volume (SIV) can be significantly reduced through loss repair programmes. The cost of water can be reduced by increased treatment by the Maselspoort WTW and by implementing wash water recovery systems. The revenue from water can be increase significantly by increasing the meter coverage and implementing appropriate meter tariffs. For this purpose a 10 year strategy was developed (MMM, 2014b).
- Thirdly, MMM is currently importing a significant amount of water from the Caledon river. Most of the return flows from Bloemfontein's WwTW's is discharged in the Rhenosterspruit and bypasses Bloemfontein. This effectively translates into a Caledon-Vaal transfer scheme. An effluent **transfer pipeline** can transfer water from the Rhenosterspruit to Mockes dam into the Modder River. The existing Mockes dam can therefore be used as an **engineered buffer** between the treated effluent and planned potable water reclamation facility at Maselspoort WTW.
- Fourthly, A significant **potable water reuse** potential exists in Bloemfontein to reduce the water purchased from Bloem Water and use local resources in a more optimal manner. Maselspoort WTW can be refurbished and upgraded to increase the treatment capacity to 140 Ml/d and add additional unit treatment processes to enable potable reuse.
- Fifthly, the **effluent quality** from a number of WwTW in Bloemfontein does not comply with effluent standards and in view of potential water reuse this effluent quality needs to be improved through refurbishment, expansion and process upgrades – in particular Bloemspruit WwTW. MMM has already commenced with the investigations to scope required upgrades.

and the size(and cost) of external sources will increase significantly. MMM is currently also constrained by agreement to treat a maximum of 30% of the total water sales at Maselspoort. In 2013/14 the annual average production rate at Maselspoort was only 50 Ml/d as a result of the constraints imposed by the agreement and also as a result of the treatment bottlenecks.

- Finally, despite the numerous optimisations mentioned above the water resources to MMM will eventually be inadequate to meet the growing demand and an additional external resource will have to be developed. Water conservation and demand management and water reuse will augment the water supply to Bloemfontein significantly, but it is projected to satisfy the demand only for the next ten years (refer to Figure 3.2). In addition to the above a parallel feasibility study (this study) was commissioned to evaluate long term **augmentation schemes** from the Orange River system (Gariep dam) to meet 2035 demands. The **Gariep Augmentation Project (GAP)** is currently the preferred external source.

The question may be rightly asked; why the drive to optimise the utilisation of local resources and what bearing does water reuse have on the Gariep transfer scheme? **Firstly** local resources are more cost effective to develop due to much shorter pipelines between the water resources and the demand centres. A good case in point is the development of the **local** Maselspoort water reclamation plant which is currently estimated to cost about R5 million per Ml/d of capacity whereas an **external** transfer scheme from Gariep is currently estimated at about R20 million per Ml/d. The difference in capital cost (a factor of about four) is directly proportional to the distance the water needs to be transferred. Apart from the capital cost differences operational cost savings can also be realised by using local resources as longer transfer lengths require higher pumping costs. The **second** reason is that local resources are often more cost effective to operate as well due to much less energy required to transfer water over long distances. By integrating the lower investment cost and lower operating cost of a Maselspoort system (estimated at about R2/m^3) with the higher investment cost and higher operating cost of a Gariep scheme (estimated at about R3,5/m^3) a significant level of cross subsidisation can be achieved, resulting in a lower tariff increases.

2.2. Purpose of the Technical Feasibility Study and Report

The primary focus of the Gariep dam Augmentation Project (GAP) is the development of the Gariep transfer scheme, but the scoping of this project is intricately linked to the successful implementation of all the other water efficiency initiatives previously listed. It is therefore important to define the scope of the other related projects before GAP project scope can be finalised. Not all of these projects are at the same stage of development and this complicates the finalisation of the scoping of the GAP. The purpose of this feasibility study report is to:

- Define the need for additional water
- Describe water sources and supply options considered
- Describe the Gariep Augmentation Project
- Describe the interfaces and dependencies with existing systems
- Determine if the Gariep Augmentation Project

The report is presented in seven parts:

- Part I – Project introduction and background
- Part II – Water service requirements and supply options
- Part III – Engineering of the GAP
- Part IV – Cost estimation and valuation
- Part V – Project execution and support
- Part VI – Risk assessment and due diligence

- Part VII – Conclusions and recommendations

Each part will be discussed in more detail in the subsequent sections.

2.3. Applicable Legislation

A municipal entity such as MMM is subject to a plethora of national legislation and regulations. Most applicable to this study are the Constitution of the Republic of South Africa (108 of 1996), the National Water Act (36 of 1998), the Water Services Act (108 of 1997), the Municipal Finance Management Act (56 of 2003), the Municipal Structures Act (117 of 1998), Municipal Systems Act (32 of 2000), the National Environmental Management Act (107 of 1998), The Environmental Conservation Act (73 of 1989), National Heritage Resources Act (25 of 1999), Mineral and Petroleum resources Act (28 of 2002) and the Occupational Health and Safety Act (85 of 1993)

2.3.1. The Constitution of the Republic of South Africa

The Constitution creates the mandate for local authorities to provide a range of services one of which is water services. The services need to be delivered in an equitable, fair, affordable and suitable manner.

2.3.2. National Water Act

The National Water Act provides the framework for the development and management of water resources and describes the different types of water uses.

2.3.3. Water Services Act

This act provides a range of definitions pertaining to the water services and the structure providing water services. The act defines water services authorities; water services providers and water services intermediaries.

2.3.4. Municipal Systems Act

The sections of particular relevance to this project are section 76, 77 and 78 that describes the mechanisms and processes a municipality need to follow to decide on and implement external service mechanisms. Section 78 also indicated the need to conduct a feasibility study in the case of an external mechanism.

2.3.5. Municipal Finance Management Act

This act describes how municipal finances need to be managed and prescribes the development of budgets and recovery of cost. Of particular interest is the new regulations published in terms of public-private partnerships.

2.3.6. National Environmental Management Act

The act defines a range of environmental impacts and how these impacts need to be reduced, managed and authorised. Of particular interest to this project is the disposal of waste and the environmental impact of the

project during construction and during operation. The National Environmental Management Act (NEMA) is increasingly being linked/integrated with the requirements of the National Water Act.

Since the publication of NEMA a number of additional environmental management acts were published, these include:

- National Environmental Management: Protected Areas Act (57 of 2003)
- National Environmental Management: Air Quality Act (39 of 2005)
- National Environmental Management: Waste Act (59 of 20008)

2.4. National, provincial and local municipality policies

In addition to national legislation various national, provincial and local municipality policy and strategy documents have been published. One of the most important strategy documents pertaining to water source development is the National Water Resources Strategy. The revised National Water Resources Strategy highlights the water scarcity in RSA and ways to improve water uses in various industries. Of particular interest is the focus placed on water reuse as a means to optimise national water resources.

Other important policies include: Free State Spatial Development Framework, Free State Growth and Development Strategy, MMM – Integrated Development Plan, MMM – Water Services Development Plan and MMM – Water Services By-laws.

A separate report deals with the legal frameworks and policies applicable to water services (MMM, 2015i).

2.5. Municipal water services

Mangaung Metro Municipality (MMM) is a Water Service Authority and is responsible, in terms of the Constitution of the Republic of South Africa, the Municipal Structures Act and the Water Services Act, to ensure that water supply services are provided in an efficient, affordable, economical and sustained manner to its consumers. Clause 11(1) of the Water Services Act (108 of 1997) requires that:

"*Every water services authority has a duty to all consumers or potential consumers in its area of jurisdiction to progressively ensure efficient, affordable, economical and sustainable access to water services*".

The responsibility also comes with significant obligations in terms of Clause 11(3);

"In ensuring access to water services a water services authority must take into account, among other factors:

a) Alternative ways of providing access to water services;
b) The need for regional efficiency;
c) The need to achieve benefit of scale;
d) The need for low costs;
e) The requirement for equity; and
f) The availability of resources from neighbouring water services authorities."

Furthermore it should be noted that apart from the requirements of clause 11 of the Water Services Act, Clause 6 requires that *"…no person may use water services from a source other than a water services provider nominated by the water services authority having jurisdiction in the area in question, without the approval of that water services authority*".

A municipal entity can also contract a water services provider to provide water and sanitation services. The Water Services Act does, however, not prohibit a Water Services Authority (WSA) to act as its own Water Services Provider (WSP). It also does not prohibit a water services authority to develop its own water supply systems, i.e. bulk infrastructure. MMM appointed Bloem Water as a WSP for the Bloemfontein (partially), Thaba Nchu and Botshabelo areas. MMM is, however, also operating its own bulk water infrastructure at the Maselspoort WTW to supply Bloemfontein.

It is important to note that similar obligations are placed on a Water Services Provider (WSP) in terms of Clause 34(1), in this case Bloem Water.

"In performing its activities, exercising its powers and carrying out its duties a water board must achieve a balance between:

(a) Striving to provide efficient, reliable and sustainable water services;
(b) Optimally using available resources
(c) Striving to be financially viable
(d) Promoting the efficiency water services authorities
(e) Taking cognizance of the needs of water services institutions, consumers and users;
(f) Taking into account national and provincial policies, objectives and developments;
(g) Acting in an equitable, transparent and fair manner
(h) Comply with health and environmental policies; and
(i) Taking reasonable measures to promote water conservation and water demand management."

Taking the above list of obligations into consideration it is debatable if Bloem Water has in recent times fulfilled their mandate in terms of the Water Services Act. The clear lack of adequate planning, frequent water shortages and inequitable water tariffs are cases in point.

2.6. Project History

2.6.1. Project initiation

In view of the historic performance of Bloem Water and projected shortages in terms of bulk water resources and systems, MMM decided to reassess the current water service provision model. MMM realised that sustainable, integrated and cost effective water services will be compromised if in-house planning for additional bulk water sources are not done as a matter of urgency. It also became evident during recent discussions with DWS that the proposed resource developments as indicated in the Bloemfontein reconciliation study (DWS, 2012) will not be able to deliver the required bulk water sources in time. In addition the reconciliation study did not intend to optimise the use of local resources through potable reuse at this stage and only reserved this option for a much later stage. Even the accelerated action plan report (DWS, 2014) did not reflect the accelerated implementation of water reuse.

MMM has therefore, as part of their obligation in terms of the Water Services Act, embarked on a process to explore and plan the most cost effective use of local resources as well as the planning of a new external water source augmentation scheme, referred to as the Gariep dam Augmentation Project (GAP).

The project was initiated by MMM during 2014 after issuing request for proposals for panel applications. Bigen Africa was appointed as the lead consultant. A high level pre-feasibility study was completed by MMM (MMM, 2014d). In this report the preliminary scope, cost and timelines of GAP was described. Subsequently three additional consultants were appointed to support Bigen Africa, i.e. LTE, Glad Consulting and Phetogo Consulting. The brief to the consulting team was to develop a bulk water supply system as an alternative source to Bloemfontein from the Gariep dam. This feasibility study is the second step in the development of such a transfer scheme.

2.6.2 Decision Gate Processes Followed

The following decision gates were passed:

- Date of initiation of pre-feasibility study - April 2014
- Pre-feasibility completed – July 2014
- Presentation to council and acceptance to proceed with feasibility study - November 2014
- Commenced with feasibility study – January 2015

In parallel to the decision gates applicable to MMM, a number of stakeholder workshops were held between DWS, MMM and Bloem Water. During these deliberations it became clear that urgent decisions had to be made in order to avoid water shortages. This was raised in a letter to DWS dated March 2015 (MMM, 2014e). The issues highlighted were:

- DWS was to inform Bloem Water that MMM was currently in the process to complete a feasibility study to investigate the augmentation of bulk water supply to Bloemfontein directly from the Gariep Dam. Bloem Water should accordingly not proceed with a similar investigation in order to **prevent duplication** of work.
- Until the feasibility study has been completed, DWS should instruct Bloem Water that all capacity upgrade programs associated with their infrastructure be **stopped**.
- DWS to assist MMM in renegotiating the Bloem Water supply agreement in which MMM (as water services authority) is charged at unfair raw water rates for water abstracted at Maselspoort WTW.
- MMM to assist DWS in revising the Orange River Reconciliation study with appropriately phased water reuse potential, capital and operating cost.
- DWS to instruct Bloem Water to engage with MMM on all aspects of planning that could potentially impact on the additional cost to the consumer as per the requirements of the Water Services Act.

No feedback was received from this letter and it is not known if DWS has issued these instructions to Bloem Water. In view of the fact that Bloem Water is proceeding with the detail designs and the EIA process of Rustfontein WTW upgrade, this does not appear to be the case. MMM is in the process of following up this matter and escalate the letter addressed to the DWS regional office to the office of the DWS:National.

2.6.3 Options History

The details of the options considered during the development of the GAP are discussed in detail in a later section. These options have been largely influenced by the regional water balance (section 3.1) as well as the optimisation of local resources and water efficiency improvements discussed previously.

During the pre-feasibility study, after the capacity of the GAP was determined a number of pipeline routes were assessed and it was found that a direct route between Gariep dam and Bloemfontein is the most feasible option.

2.7. Project definition

2.7.1. GAP in relation to MMM Bulk Water and Sanitation capital programme

The GAP is not the only capital project currently under development by MMM. Figure 2.1 below indicates the high level MMM water and sanitation projects and work packages currently under consideration. A number of these projects/work packages impacts on the capacity and phasing of the GAP in particularly the WCDM and water reuse projects. It should be noted at this stage that the inclusion of the optimisation of the local water sources have been entrenched in determining the scope and work breakdown structure of the GAP. The GAP, in its current form, can therefore not be implemented without a parallel implementation of the other local water optimisation projects. If the local water reuse and WCDM initiatives are not implemented in time, the size of GAP could potentially be twice as large, i.e. 400 Ml/d. A system this size will be very costly and unaffordable to the greater Bloemfontein area. A detailed work breakdown structure is included in Annexure C.

Figure 2.1 – MMM Water and Sanitation Capital Programme work package diagram

The GAP project comprises a number of infrastructure, support services, investigations and project management work packages. The high level work packages and work breakdown structure is discussed in more detail in Section 12. The current scope involves a new abstraction works at the Gariep dam, a raw water pumping station, transfer pipelines to a water treatment works located at a suitable site near the Gariep dam. Potable water is then pumped to a high point and stored with a further booster pumping station for final delivery into a terminal reservoir in Bloemfontein. Support services for bulk power and communication needs to be provided. Numerous detailed site investigations are still required for topographical, geotechnical, environmental etc. Project management activities involve activities in accordance with the internationally recognised PMBOK guidelines.

2.8. Strategic planning and alignment

It is essential that the GAP project is supported by the internal strategic documents of MMM. These strategic documents provide a framework that guides and align infrastructure development in MMM and funding in an integrated manner.

Unfortunately during the recent MuSSA assessment of the various planning documents by DWS (DWS, 2015k) it was noted that all the planning are not necessarily coordinated and integrated and that a significant level of discrepancy exists between the various planning documents. Several reasons can be given for these discrepancies, the most prominent reason is the fact that several new initiatives have been launched by MMM and the planning documentation did not necessarily keep pace with these project developments. In order to access grant funding, the integration of the planning documentation will have to be addressed. It is also important that the GAP and supporting local water optimisation projects are included in the IDP, WSDP and MTREF budgets.

MMM needs to update the planning documentation during the BFS phase of the project in order to satisfy the requirements to access grant and other funding. The key planning documents that require integration include:

- Integrated development plan (IDP)
- Water services development plan (WSDP)[5]
- Medium term revenue and expenditure framework (MTREF)
- Blue drop, green drop and no drop requirements assessments
- Greater Bloemfontein reconciliation study
- Built environment performance plan

2.9. Government notification and meetings

MMM was in discussion with numerous government departments during the course of a financial year. The most prominent and relevant to this project include the Department of Water and Sanitation (DWS) and National Treasury and Department of Cooperative Government and Traditional Affairs. The following meetings have been held recently with DWS:

[5] Clause 13 of the Water Services Act 108 of 1997 is clear on requirements of the a water services development plan (WSDP) and in this particular case sub-clause 13(h) is highlighted.

"Every draft water services development plan must contain details:…..

(h) regarding the future provision of water services and water for industrial use and future disposal of industrial effluent, including

(i) water services providers which will provide water services

(iii) proposed infrastructure necessary

(iv) the water sources to be used and the quantity of water to be obtained from and discharged into each source

(v) the estimated capital and operating costs of those water services and the financial arrangements for funding those water services, including the tariff structures;

(vii) the operation, maintenance, repair and replacement of existing and future infrastructure

(j) of existing and proposed water conservation, recycling and environmental protection measures."

- In November 2014 a meeting was held with DWS:Pretoria to discuss the need for the Gariep pipeline and the need to maximise water reuse. It was agreed by DWS that the Reconciliation Study (DWA, 2012) be adjusted to bring the implementation of water reuse forward. DWS also agreed to convene a workshop to discuss the various water augmentation options available to Bloemfontein.
- In January 2015 a workshop was arranged by DWS:Free State between Bloem Water, MMM and DWS to discuss the information that was available in order to assess the MMM bulk water augmentation options that have been considered to date. It was decided that Bloem Water does not have sufficient information and that they be given an opportunity to catch up with the work already prepared by MMM.
- In March 2015 a follow up workshop was held between DWS, Bloem Water and MMM. During this session various water augmentation options were compared. It was clear that the shortest route between Gariep dam and Bloemfontein presents the option with the lowest capital and operating cost. DWS indicated that an internal meeting will be held to decide on the most suitable option. MMM indicated that they will proceed with the GAP feasibility study:

The following meetings have been held recently with National Treasury

- 26 and 27 February 2015 – National Treasury PPP training by 4 senior MMM officials
- 26 May 2015 – Meeting between MMM HOD:Engineering services and National Treasury regarding the possible funding of GAP.

2.10. Related Reports and Studies

A range of studies have been commissioned by MMM and DWS during 2014 and 2015 that are directly or indirectly related on the Gariep dam Augmentation Project. The most recent reports are listed below:

- Water reconciliation strategy study for the large bulk water supply systems:Greater Bloemfontein area – final reconciliation strategy (DWA, 2012)
- Bloemfontein reconciliation strategy, Accelerated action plan to augment Bloemfontein's water supply (DWS, 2014)
- Integrated city development grant – built environment performance plan (MMM, 2014a)
- 10 year WCDM strategy (MMM, 2014b)
- Preliminary Engineering Design Report – Maselspoort WTW (MMM, 2012c)
- Gariep pre-feasibility study (MMM, 2014d)

A number of reports/studies are also either in draft form or are still being conducted as part of GAP. These reports are listed below:

Name of report	Status	Reference
Gariep feasibility study pipeline optimisation, Bigen Africa	Summarised	2015a
Draft Environmental feasibility report for the proposed Gariep dam bulk water supply scheme, GA Africa,	Summarised	2015b
Investment valuation report, Ernest and Young	In development	2015c
Affordability report, Ernest and Young	In development	2015d

MMM water tariff structure report, Ernest and Young	In development	2015e
Water revenue and cost structures report, Ernest and Young	In development	2015f
Macro-Economic Impact Assessment report, Urban-Econ	Summarised	2015g
Structuring and funding report, Cresco	In development	2015h
Legal and regulatory report, Bigen Africa	In development	2015i
Internal bulk distribution report, Bigen Africa	In development	2015j
DWS MmuSSA report	In development	2015k
Small town report, Phetogo	In development	2015l
PV report, University of Stellenbosch	In development	2015m

Table 2.1 – Summary and status of Gariep Augmentation Project related investigations and reports

MM is also aware of studies that were conducted by Boem Water in reaction to the studies performed by MMM regarding upgrades to the Welbedacht system, the Rustfontein system and the Tienfontein pumping station. Not all of these documents could, however, be located at the time of compiling this report and should be obtained during the BFS phase.

PART II – WATER SERVICE REQUIREMENTS AND OPTIONS

3. STATUS QUO - WATER REPORT

3.1. Water resources

3.1.1. Historical Yield of Existing Surface Water Sources

The Water Reconciliation Strategy Study (WRSS) Report prepared by DWA (2012) includes detail on the availability and scarcity of raw water in the region and further exploitation of sources that could be pursued. Based on information provided in the WRSS Report, an assessment of the adequacy of the existing raw water sources for the Greater Bloemfontein area was provided in the Gariep dam pre-feasibility study report (Bulk Water Supply to the Greater Bloemfontein Area from Gariep Dam) dated July 2014 (MMM, 2014). Information from the pre-feasibility study report is summarized in the following paragraphs.

The yield of the system supplying the Greater Bloemfontein area and small towns along the route of the Welbedacht-Bloemfontein pipeline is indicated as 84 million kℓ per annum (230 Mℓ per day). The yield is made up as follows:

- Groothoek Dam — 3 million kℓ per annum (8,2 Mℓ per day)
- Rustfontein-Mockes Dam subsystem — 8 million kℓ per annum (21,9 Mℓ per day)
- Caledon transfer system — 89 million kℓ per annum (243,8 Mℓ per day)
- Adjustment to system[6] — -16 million kℓ per annum (-43,8 Mℓ per day)
- **Combined yield** — **84 million kℓ per annum (230 Mℓ per day)**

The combined system yield needs to be reduced with 1 million kℓ per annum and 2 million kℓ per annum to respectively accommodate the impact of the Metolong Dam and Environmental Water Requirements. The remaining yield is therefore 81 million kℓ per annum (222 Mℓ per day).

As indicated in the WRSS Report, smaller towns account for approximately 4% of water supplied by Bloem Water which leaves 78 million kℓ per annum (213,7 Mℓ per day) for the Greater Bloemfontein area.

The total volume of water supplied to Bloemfontein, Botshabelo and Thaba Nchu by Bloem Water during the 2013 calendar year amounted to 88 million kℓ (241 Mℓ per day) which exceeds the yield available to the Greater Bloemfontein area by approximately 13%. Severe water shortages were experienced in the Bloemfontein supply area during 2013 and had shortages not been encountered, the volume supplied during 2013 would have been more than 88 million kℓ (241 Mℓ per day) and would thus have resulted in a shortfall in excess of 13%. The following should, however, also be borne in mind:

[6] *Referred to in WRSS as adjustment of the system to incorporate recent operating information and hydrology.*

- The Groothoek Dam is virtually empty and currently provides no or little yield towards the system which effectively reduces the available yield by as much as 3 million kℓ per annum to 75 million kl per annum.
- Environmental Water Requirements may not have been implemented yet
- A portion of the water treated at Maselspoort (although sold by Bloem Water as raw water supplied to Maselspoort) is from indirect reuse (treated sewage effluent from Botshabelo and Thaba Nchu) and therefore does not impact on the available yield from the Caledon and Modder sub-systems.

The current yield of the water resources available to the Greater Bloemfontein area is between 75 and 78 million kℓ per annum (205.5 and 213,7 Mℓ per day). The yield from existing surface water sources is therefore insufficient to meet the current water demand of the Greater Bloemfontein Area which amounted to 88 million kℓ (241 Mℓ per day) during 2013 and 86 million[7] kℓ (235 Mℓ per day) during 2014.

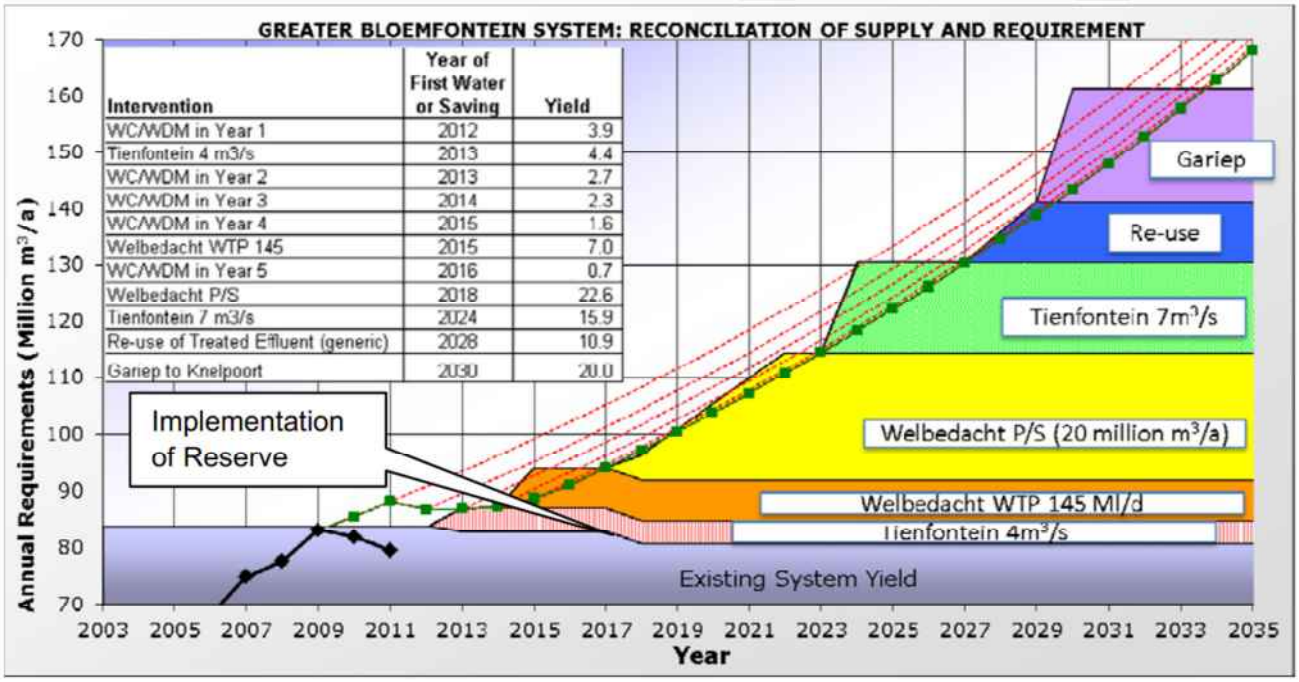


Figure 3.1 - Extract from Greater Bloemfontein reconciliation study (DWA, 2012)

The existing system yield is indicated as about 85 million kℓ per annum (fig 3.1) and shows that the current demand has already exceeded the yield of the current system. In this arrangement the development of new sources superimposed on top of the existing system yield, but water reuse and the Gariep dam options were planned to be developed only after 2027. The current approach proposed by MMM is to reverse the strategy proposed by DWS and implement water reuse as a first priority, followed by Gariep dam. [The phasing of this is shown in Figure 3.2.]

[7] The reduction in water demand can probably be attributed to already constrained supply ability during peak demand areas and the impact of an active WCDM programme implemented by MMM.

It is also interesting to note that in Figure 3.1 the projected demand was reaching 160 million kℓ per annum (465 Ml/d) in 2035 and resources had to be developed to meet these demands. In Figure 3.2, the projected demand at a 2% growth rate was reaching 146.7 million kℓ per annum (402 Ml/d) in 2035. The resources required to meet this demand includes the water reuse resource (which comprises the return effluents from Thaba Nchu, Botshabelo and Bloemfontein) and the Gariep dam.

3.2. Water Demand

3.2.1. Historic Water Consumption

Historic and projected future water consumption in the Greater Bloemfontein Area have been considered in the pre-feasibility study report (MMM, 2014d). The impact of water conservation and water demand management initiatives, new developments and the eradication of VIP's on water demand in the Bloemfontein area was taken into consideration in the pre-feasibility study report and discussed below.

Projected water demands in relation to resource yield requirements are indicated in **Figure 3.1**. The year 2035 was adopted as a design horizon and two growth scenarios were used, a 1% growth scenario and a 2% growth scenario.

3.2.2. Water Conservation and Water Demand Management

The demand figures generated assumed a significant level of WCDM interventions. Without these interventions it is expected that the project demands will increase beyond the 2% growth rate. For more detail on the WCDM initiatives planned by MMM refer to the recent 10 year WCDM strategy report (MMM, 2014b).

3.2.3. New Developments in Bloemfontein

At the time of developing this TFS a number of new housing developments have been approved by MMM. These housing developments will increase the water demand over time and has been allowed for in the total demand figures. Details of the planned demand increases as a result of these housing developments can be found in the MMM internal distribution system upgrade report (MMM, 2015j) and the GAP prefeasibility study (MMM, 2014d).

3.2.4. VIP Eradication Programme

As part of their social responsibility MMM is in the process of eliminating all VIPs in their area of responsibility and replacing it with water borne sanitation. This will in turn increase the water use for areas previously served by VIPs and will increase the water supply capacity requirements even more.

3.2.5. Water Re-use

A significant amount of treated effluent is discharged into the Rhenosterspruit and leaves the Bloemfontein area through the Modder river downstream of Maselspoort. A potable water reuse system has been accepted by MMM as a means to increase the yield of the system by at least 18.25 million kl per annum (50 Ml/d). Water

reuse can increase the current treatment rate of Maselspoort from about 80 Ml/d to 130 Ml/d as indicated by the brown shaded area in Figure 3.3.

3.2.6. Water demand for small towns

Potential water supply to small towns along the route from Gariep dam to Bloemfontein was investigated. This matter is dealt with in a separate report (MMM,2015l). It would appear that the small town demand amounts to less than 5% the total Greater Bloemfontein demand and that most of the small towns have adequate water supply systems. The small town demands that needs to be supplied from GAP will be quantified in the first version of the TFS.

3.2.7. Projected Future AADD and 7-day Sustained Water Demand

The extent to which the AADD and 7-day sustained demand exceeds the current system yield water treatment and supply infrastructure capacity is summarised in **Table 3.1**. These figures are based on the assumption that the current system yield is 78 million kℓ per annum and the assumption that the current AADD water treatment plant and bulk supply system capacities for the Greater Bloemfontein Area amounts to 325 Mℓ per day (Groothoek excluded), i.e. 100 Mℓ per day for the Rustfontein system, 145 Mℓ per day for the Welbedacht[8] system and 80 Mℓ per day for the Maselspoort system[9]. Both the 1% and 2% growth scenarios were calculated. It is evident that water supply augmentation from the Orange River to the Greater Bloemfontein area should cater for average annual daily demand of 112(189) Mℓ per day and peak demand of 100(208) Mℓ per day for the 1%(2%) growth scenario to meet the 2035 7-day sustained demand.

A growth scenario of 2% was adopted for the planning of the GAP. This implies a GAP peak scheme capacity of 200 Ml/d by 2035.

Year	Projected Water Demand (million kℓ per annum)	Shortfall in Existing Resource Yield (million kℓ per annum)	Shortfall in Existing Resource Yield (Mℓ per day)	7-Day Sustained Peak Demand (Mℓ per day)	Surplus (Shortfall) in Infrastructure Capacity to Meet 7-Day Sustained Peak Demand (Mℓ per day)
2014	89 (90)	11(12)	30(33)	341(345)	14(10)
2025	107(120)	29(42)	79(115)	412(462)	57(107)
2035	119(147)	41(69)	112(189)	455(563)	100(208)

Table 3.1 - Summary of Projected Water Demands, Resource Yield Requirements and Bulk Water Infrastructure Capacity Requirements
(The figures outside the brackets indicate the values for a 1% growth scenario and the figures in brackets indicate the values for a 2% growth scenario.)

[8] *This figure is optimistic as it is known that the Welbedacht system cannot produce 145 Mℓ per day during times of high turbidity.*
[9] *The theoretical capacity is 110 Ml/d, but due to technical reasons and raw water charges it is not cost effective to operate the works above 80 Ml/d.*

A graphical representation of the demand and the system yield is shown in Figure 3.2. The **black lines** indicate the Average Annual Daily demand (AADD) demand for the greater Bloemfontein area (inclusive of small towns currently supplied from the Welbedacht WTW). The three different black line types represent the 1%, 2% and no WCDM growth scenarios. The **blue shaded** area indicates the yield of the Caledon river system. The brown shaded area represent the Modder river yield. The **brown shaded** area increases in 2017 and represents the increased reuse from the Modder river (through transfers from WwTW effluent currently discharged in the Rhenosterspruit). The **purple** shaded area represents the future supply increase from the Gariep dam.

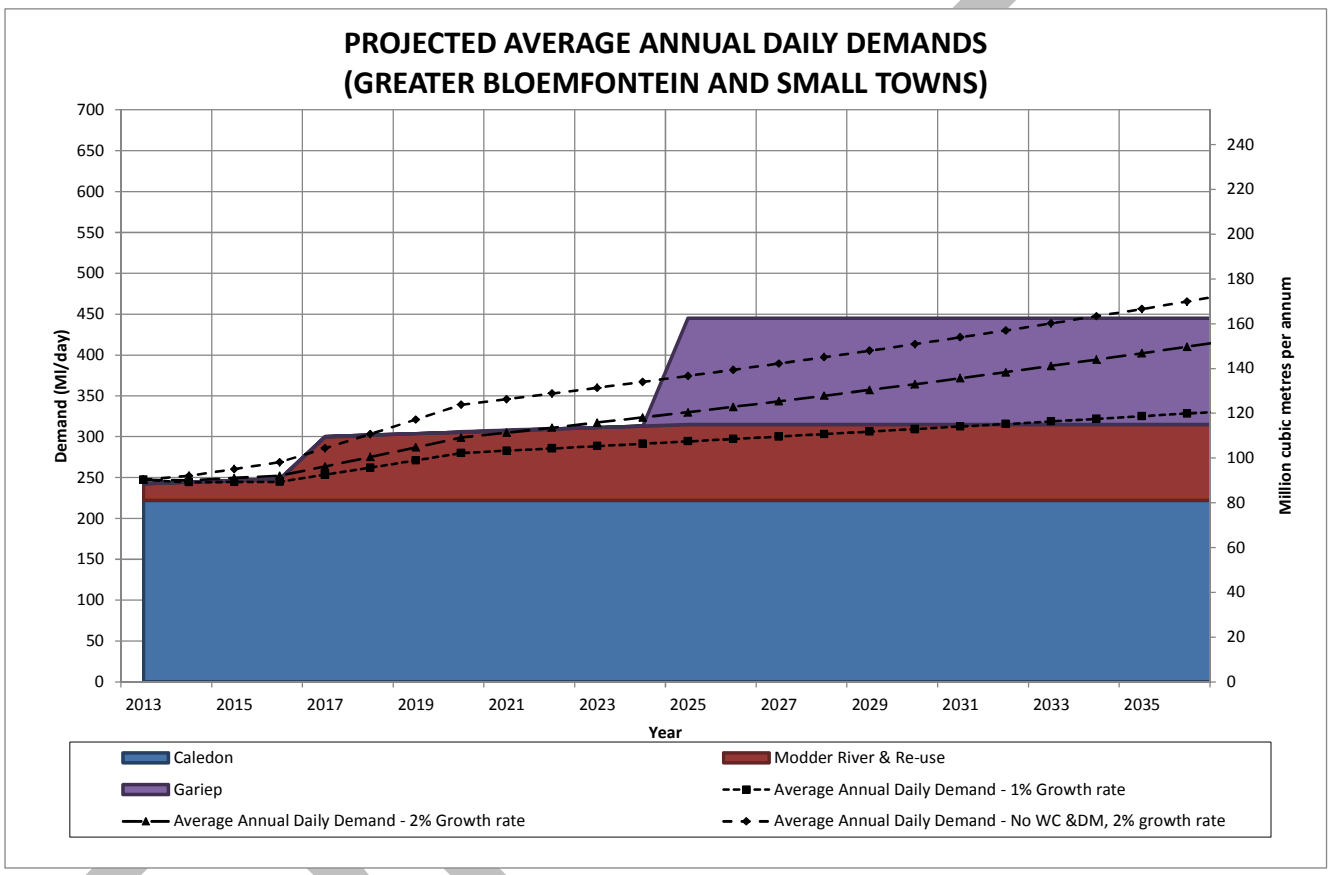


Figure 3.2 - Water resource development phasing for Greater Bloemfontein area

It is clear from Figure 3.2 that the current resources can only just meet the AADD demand and without implementing WCDM, MMM could experience water resource availability shortages as early as 2017. With the implementation of water reuse, MMM will be able to meet the AADD demand until about 2032(2022) on the 1%(2%) growth curves. An additional 112 Ml/d (189 Ml/d) is required to meet the 2035 AADD demand for the 1%(2%) growth scenarios.

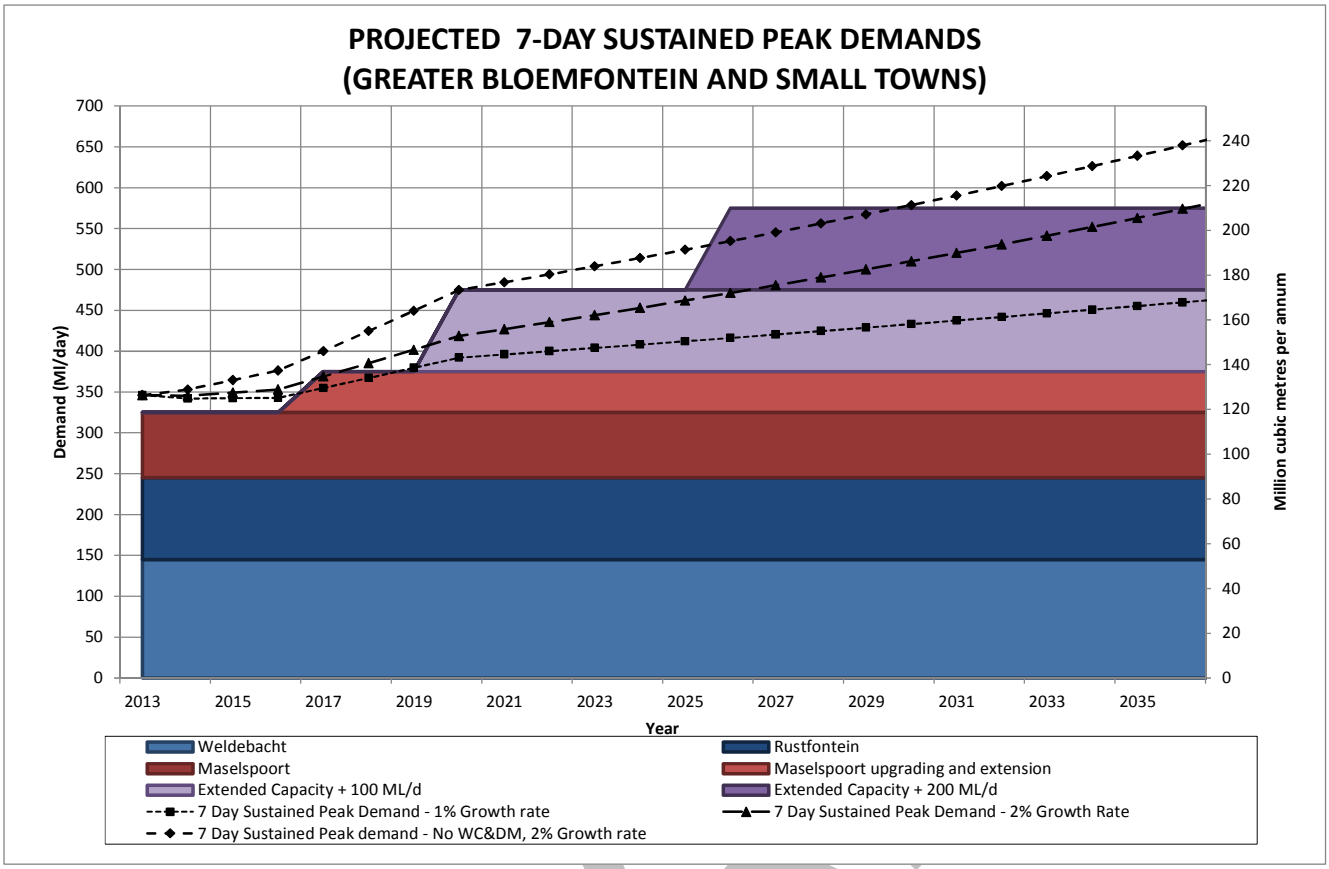


Figure 3.3 - Water supply systems and project average and peak water demand

Whereas the AADD determines the system yield, the 7-day sustained demand determines the capacity of the water supply systems. Figure 3.3 indicates the demand and the capacity of the current and future water supply systems. The projected demands include for 3% bulk supply system losses so as to reflect the volume of water to be supplied to the water distribution systems and water treatment plant losses were assumed to be 5%.

The **black lines**, in Figure 3.3, indicate the 7-day sustained (assuming a peak factor of 1.4) demand for the greater Bloemfontein area inclusive of small towns (currently supplied from the Welbedacht WTW). The three different black line types represent the 1%, 2% and no WCDM growth scenarios. The **blue shaded** areas indicate the combined capacity of the existing water supply systems including Rustfontein and Welbedacht WTW. It was assumed that the capacities for Maselspoort, Welbedacht and Rustfontein WTW were 80, 100 and 145 Ml/d respectively[10]. The **brown shaded** areas indicate the initial and expanded capacity of Maselspoort WTW. The two **purple** shaded areas represent the phased supply increase from the GAP in 100Ml/d steps.

It is clear from Figure 3.3 that the implementation of Maselspoort WTW upgrade will enable MMM to meet peak water demand until about 2019 for a 1% demand growth. An additional 100 Ml/d from the GAP can meet peak demand until 2035 based on a 1% demand growth and until 2027 if based on a 2% demand growth. A second 100 Ml/d upgrade is required beyond 2027 if the demand growth projections are higher than 2%.

[10] This figure assumes that all water treatment and transfer system can operate at the rated capacity throughout the year. It is know from historic experience that Welbedacht and Maselspoort WTW experience treatment problems during periods of high silt and algae loads and that the treatment capacity can be reduced by as much as 50% during these times for weeks at a time.

From a total water supply point of view it is clear that additional external water will be required to meet average and peak demand regardless of the demand growth scenario. The challenge is to determine the most economical way to operate the various water sources and supply system in order to minimise the operating cost. i.e. cost of water to consumer. The optimisation of the operating cost will be addressed later in the report (Section 8).

3.3. Existing water supply systems

The pre-feasibility study considered the various sources from a number of different perspectives. The sources were compared in terms of:

- Reliability of Raw Water Sources
- Treated Effluent from Bloemfontein, Botshabelo and Thaba Nchu
- Raw Water Quality
- Raw Water Losses
- Reliability of System Infrastructure and Maintenance Requirements
- Energy Efficiency
- Summary of existing Water Supply Systems

The comparison of the different sources will be expanded in the final version of the TFS.

3.4. Gap analysis

3.4.1. Gaps identified from IDP, WSDP, BEP, MTREF, WCDM and Reconciliation reports

a) Gaps identified from MMM planning documents

A number of inconsistencies exist between various MMM planning documents. These inconsistencies have resulted partially as a result of the pace at which new developments have taken place with regards to water supply system planning and partially because the planning documents were not generated at the same time. A number of planning documents do, however, recommend that the total water supply to the greater Bloemfontein be expanded.

b) Reconciliation study gaps

The DWS Greater Bloemfontein reconciliation study (DWS, 2012 & DWS,2014) showed water reuse as a last resort as it was believe that desalination would be required. It was, however, shown in reports (MMM, 2014c) that salinity levels despite, recycling are still well within the SANS TDS guidelines and will therefore not require desalination. This reduces the treatment cost significantly and should justify water reuse as a priority. DWS indicated that the reconciliation study (DWS, 2012) will be adjusted to reflect this re-prioritisation. This fundamental oversight could potentially impact on the planning that is currently being performed by DWS and Bloem Water and it was for this purpose that DWS was requested to stop Bloem Water from making any long term decisions until the reconciliation study has been adjusted.

3.4.2. Trigger based gaps

The fact that MMM has experienced extended water shortages in the past, for a number of reasons, was a key trigger to commence with this feasibility study.

4. TECHNICAL OPTION ANALYSIS REPORT

4.1. Introduction to option analysis

4.1.1. No change option

The no change option is included for the sake of completeness and is only a theoretical consideration. Without an additional long term water source Bloemfontein will experience severe water shortages and this will stifle the local economy. Without augmentation of the current bulk supply consumers will experience frequent and extended water interruptions, especially during the hot summer months. Even though MMM can do a lot to optimise its current water resources, the 'no change' option is not recommended.

4.1.2. Optimisation of local resources

The optimisation of existing **local resources** has been discussed in detail in the introduction and will not be repeated in full again in this section. It will suffice to say the optimisation of local resources include:

- Improved treated effluent quality from all waste water treatment works
- Transfer of Rhenosterspruit to Modder river (Mockes dam)
- Potable water reuse at Maselspoort WTW
- Water conservation and demand management

In order to optimise the local resources treated effluent needs to be transferred to Mockes dam to be treated to potable standards at an upgraded Maselspoort WTW. Once the water is treated the current WCDM programme should ensure that potable water is used efficiently and limit losses to the minimum. As the local resources have already been paid for and is therefore the most cost effective water available to MMM, it should be developed as the primary source augmentation.

Only once these sources have been optimally utilised should water imported from external sources be considered. Currently MMM is not operating local resources optimally and is heavily dependent on the importation of water from the Caledon River as a primary source. The optimal use of local resources will result in a change in the cash flow streams of both Bloem Water and MMM.

A possible way to ring fence the Maselspoort reuse and Gariep dam Augmentation Project is to provide points of sale at the point of entry into the Bloemfontein distribution system as reflected in drawing 2485.00.AAA.01.A020.

4.1.3. Expanding existing water supply systems

Sections 4.1.3 – 4.4 will be expanded in the final TFS report and will address the following aspects.

- Augmentation schemes proposed previously
- Assessment of potential bulk water supply schemes
- Criteria Applied with Conceptual Design and Assessments

- *Pipeline Route Selection*
- *Design Flows*
- *Pipeline Material and Diameter*

- **Gariep - Bloemfontein Option**
  - *Gariep Dam Outlet for Bloemfontein*
  - *Pipeline*
  - *Pipeline Route, Vertical Alignment and Length*
  - *Design Flows*
  - *Pipeline Material and Diameter*
  - *Hydraulic Design*
  - *Required Pipeline Wall Thicknesses and Grade of Steel*
  - *Surge Pressures and Surge Tank Requirements*
  - *Raw Water and High Lift Pump Stations*
  - *Water Treatment Plant*
  - *Reservoir at Longridge*
  - *Draw-offs and supply systems to small towns*

- **Gariep – Knellpoort – Rustfontein - Bloemfontein Option**
  - *Description of Main Project Components*
  - *Raw Water Abstraction from Dams*
    - *Gariep Dam*
    - *Knellpoort Dam*
    - *Rustfontein Dam*
  - *Pipeline Routes, Vertical Alignments and Lengths*
    - *Gariep Dam to Knellpoort Dam*
    - *Knellpoort Dam to Novo Outlet*
    - *Rustfontein Dam to Bloemfontein*
  - *Design Flows*
  - *Adopted Pipeline Diameters and Flow Velocities*
  - *Hydraulic design*
    - *Static Heads*
    - *Hydraulic Gradients*
    - *Required Pipeline Wall Thicknesses and Grade of Steel*
    - *Additional Pipeline Related Infrastructure*
    - *Pump Stations*
    - *Water Treatment Plant*
    - *Reservoir at Longridge*
    - *Capital* Cost Estimate
- **Gariep – Novo Outfall – Maselspoort - Bloemfontein Option**
  - *Description of Main Project Components*
  - *Raw Water Abstraction from Dams*
    - *Gariep Dam*
    - *Maselspoort Dam*
  - *Pipeline Routes, Vertical Alignments and Lengths*

- *Gariep Dam to Novo Outlet*
- *Maselspoort Dam to Bloemfontein*

- *Design Flows*
- *Adopted Pipeline Diameters and Flow Velocities*
- *Hydraulic design*
  - *Static Heads*
  - *Hydraulic Gradients*
  - *Required Pipeline Wall Thicknesses and Grade of Steel*
  - *Additional Pipeline Related Infrastructure*
- *Pump Stations*
- *Water Treatment Plant*
- *Reservoir at Longridge*

PART III - ENGINEERING

5. SITE INVESTIGATION REPORTS

5.1. Topographic surveys

A detailed topographical survey was not conducted during the TFS project stage in order to reduce cost. All designs and specialist site investigations relied on either Google images or existing mapping for topographical information. A detailed LIDAR survey will be conducted during the BFS stage.

5.2. Geotechnical Conditions

A geotechnical recognisance was conducted (MMM, 2015b). The proposed pipeline route is underlain mainly by Mudstone with small parts of some of the routes underlain by Dolerite. There are no Dolomitic areas within any of the proposed routes. A detailed study of the geology will still need to be undertaken along the final route position prior to the commencement of procurement.

No geotechnical fatal flaws were identified during the geotechnical recognisance.

5.3. Environmental impact

An Environmental Feasibility Study was conducted (MMM, 2015b) in order to aid in the making of decision on whether to proceed with the project. The Environmental Feasibility Study was carried out by undertaking the following tasks:

- Characterisation and description of the receiving environment ((biophysical aspects) followed by a high level Environmental Screening of potential issues and impacts
- Landownership and land availability assessment
- Assessment of the servitude requirements and wayleave conditions
- Land acquisition and land availability assessment
- Access and security assessment
- Feasibility assessment and,
- Environmental legislative compliance

The study focused on (4) proposed routes. These routes were compared based on the tasks which were listed above. A 700m corridor was used to determine the sections of the pipe that transverse the various aspects used in the assessment. Maps and tables were the main tool in the comparisons. Environmental sensitivities along the various routes were collated into a table. These included protected areas, threatened ecosystems, watercourses and critical Biodiversity areas. Route A was ascertained to be the most sensitive route and therefore the least preferred. Route D was established to be the least sensitive route and therefore the preferred route in terms of environmental sensitivity.

No environmental fatal flaws were identified during the environmental feasibility study.

5.4. Land Use, Land Ownership and Access

The properties affected by the pipeline and its associated infrastructure were identified through the use of the use of cadastral data sourced from the National Department of Rural Development and Land Reform. A Windeed search was undertaken using the Surveyor General (SG) codes provided to determine the detailed property information. Additionally, data that was not available from Windeed searches was sourced from the National Department of Rural Development and Land Reform.

As part of the landownership and land availability, it was determined that the properties affected by the pipeline included; government, private owners as well as communal property associations. The most preferred route in terms of land ownership was determined to be Route A as the majority of the route is located on land owned by the government. Route D was considered least preferable as the majority of the route was located on privately owned property.

In terms of access and security various points were proposed. These may be from any type of road excluding National Roads, which in relation to the proposed pipeline are the N1 and N6. Route B was the most preferred route as it had a high number of access points from other types of roads excluding the national roads. The high number of access points implies that the traversing of construction personnel and equipment in sensitive areas as well as other undisturbed land or land that used for various purposes will be minimal. Route A is the least preferred route in terms of access due to the low number of access routes available. In addition to access, security concerns both during and post construction will have an influence on the proposed routes. Routes that are in close proximity to built-up areas have a greater risk in terms of security. In terms of this an analysis showed that Route A was the most preferred route and the Route C was the least preferred.

No land use fatal flaws were identified at this stage, but is essential that negotiations with land owners commence as soon as the scope of the project has been finalised especially where private land owners are involved.

5.5. Electrical Power Supply

Power will be required at a number of positions along the pipeline corridor, provisionally at the following positions:

- At the Raw Water Pump Station between 4 and 5MVA will be required
- Water Treatment Works and High Lift Pump Station between 10 and 12MVA will be required
- Springfontein Reservoir only about 50 kVA is required
- Trompsburg Booster Pump Station between 5 and 7MVA will be required

In order to assess if power is available at these locations, discussions were held with ESKOM: Central Region planning department in Bloemfontein. The layout and configuration of the ESKOM network was determined. It was also confirmed that capacity exist at the positions along the pipeline corridor for the power requirements mentioned. Figure 5.2 indicates the ESKOM network layout around the Gariep dam area. A 360 MW hydro power station at Gariep dam feeds the national grid at the Hydra distribution station near De Aar at 220kV. Eskom's Ruigtevallei 132/66kV Substation (figure 5.1), situated in close proximity to the Gariep dam feeds a

66kV Chicadee High Voltage Transmission line (recently upgraded and built to 132kV specification for later upgrade) via Oranjekrag – Springfontein – Trompsburg – Edenburg – Reddersburg.

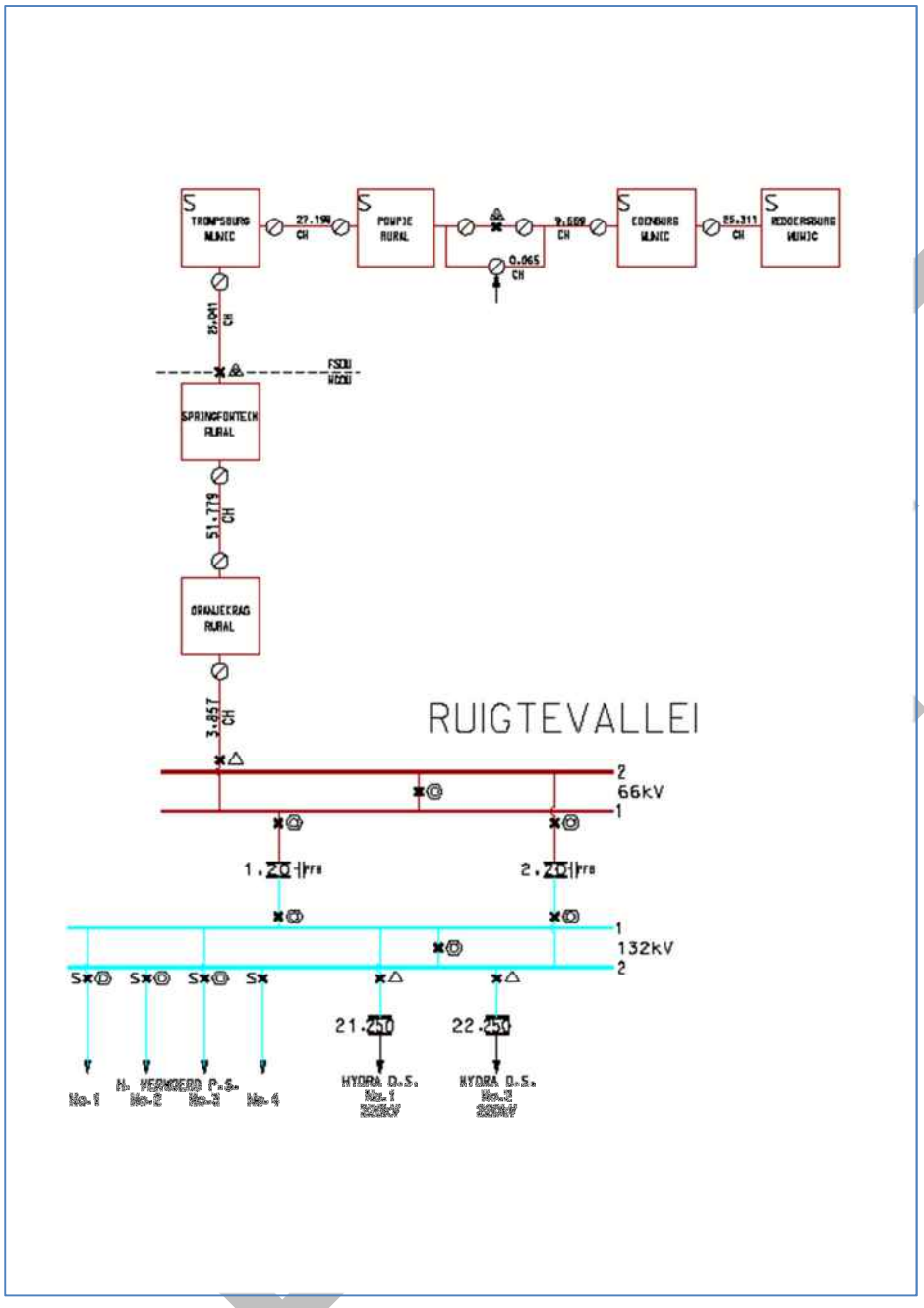


Figure 5.1 - Ruigtevallei Substation Network Diagram.

Eskom has indicated the preliminary load simulations on the recently upgraded 66kV Chicadee line (indicated in red) show that a maximum available capacity of only 5MVA will be available for the proposed booster pump station in Trompsburg. It was noted however that an additional 132kV Transmission Line terminates in Springfontein via the Zwalluw and Olive Substations from the southern direction. This 132kV line is not on the Central Region's network responsibility area, and Eskom Eastern Cape has to further investigate the possible

available capacity. This could be considered an option to supply bulk electricity to the Trompsburg booster station via a dedicated 132/22kV OHL between Springfontein and Trompsburg.

Figure 5.2 – Eskom 132kV (blue) & 66kV (red) network in Gariep Dam Area

At this stage it would appear that adequate power could be supplied at the indicated positions along the pipeline corridor. In view of the current Eskom load shedding and power supply reliability issues, other mitigating measures are also being considered these include increasing the water storage capacity at the highest point on the pipeline route and supplementing ESKOM power supply with three solar Photo Voltaic (PV) farms. A detailed assessment of the PV potential was developed as part of the TFS (MMM, 2015m). The cost implication of a grid tied PV farm will be presented in the final version of the TFS.

The capital cost for bulk Eskom applications amounts to about R42 million. It is essential that an application for power supply be lodged as soon as the positions have been finalised.

5.6. Bulk Materials Handling and Mining rights

This aspect was not addressed during the THS project stage and will be developed in detail during the BFS stage.

5.7. Economic impact

An economic impact assessment was commissioned as part of the TFS (MMM, 2015g). The report applied the capital investment and determined the impact on regional and national economic activity. The report addressed the following socio-economic aspects:

- Developed a baseline profile of the project area in terms of demographics, labour market, social development and economics
- Macro and socio-economic impact assessment
- Economic cost benefit analysis
- Opportunity cost of water

Key findings from the report included:

- The project is expected to create 8000 jobs during construction and 180 new jobs during operation
- The project is projecting to increase the regional GDP by R2.4 billion.
- The project is considered to be a feasible project with a very positive economic impact

6. ENGINEERING DESIGN REPORT

6.1. Civil and Earthworks Design

Sections 6.1 to 6.9 will be expanded in the final TFS report, the current contents is presented as work in progress.

6.2. Structural Design and Engineering

6.3. Pipeline Engineering and Optimisation of Scheme Components

The project layout for the Gariep dam Augmentation Project (GAP) is considered in more detail in the Scheme Optimisation Report dated June 2015 (MMM, 2015a). An overview of the Scheme Optimisation findings is provided in **Sections 6.3.3** below.

6.3.1. Pipeline Route, Vertical Alignment and Length

Four potential pipeline routes (A, B, C and D) between Gariep Dam and Bloemfontein have been considered. The routes are reflected on the drawings included in **Annexure A**. Pipeline route D has been identified as the most favourable and was adopted for the TFS. It is recommended that pipeline route D be adopted for further studies that will be undertaken during the BFS. This corresponds with the recommendation made in the Reconnaissance Environmental Study Report (MMM 2015b).

The length of the pipeline is 182 kilometres. Ground levels to prepare the vertical alignment along the pipeline route have been based on Google Earth data with an approximate accuracy of ±10m. Topographical survey data will be required for refinement of the design during the BFS.

6.3.2. Design flows

Water demands, losses and peak factors are discussed in **Section 3** and the design flows summarized in **Table 6.1** below are based on the scheme design capacity of 200 Mℓ per day.

Average Annual Daily Demand		
Average Capacity (Mℓ per day)	**Supply Period (hours per day)**	**Average Flow (ℓ/s)**
142,9	24	1 653
7- day Sustained Peak Demand		
Peak Capacity (Mℓ per day)	**Supply Period (hours per day)**	**Peak Flow (ℓ/s)**
200	22	2 525

Table 6.1 - Design Capacities

Allowance was made for 5% water treatment plant losses with the design of raw water pumping systems i.e. average flow of 1736 ℓ/s and peak flow of 2 652 ℓ/s.

Peak flow was adopted with the design of the GAP infrastructure. Average flow was adopted with the optimisation of the water transfer systems.

6.3.3. Project Layout

Various project layouts have been considered during the scheme optimisation process. The scheme layout adopted during optimisation of scheme components and recommended for further studies that will be undertaken during the BFS is as follows (also refer to Annexure A for a layout):

- Raw water pump station at chainage (CH) 2 km (downstream from Gariep Dam wall)
- 1400 mm diameter raw water pipeline, 12500 m length (CH 0 km to CH 12.5 km)
- Water treatment plant and high lift pump station at CH 12,5 km (north of the Gariep village)
- 1400 mm diameter rising main, 40500 m length (CH 12.5 km to CH 53 km)
- Balancing reservoir at CH 53 km (north west of Springfontein)
- Booster pumping station at CH 77 km (west of Trompsburg)
- 1300 mm diameter pipeline from Springfontein to Bloemfontein (CH 53 km to CH 182 km)
- Storage reservoir at Longridge (at the existing Longridge reservoir site in Bloemfontein)

The hydraulic gradient for the supply system from Gariep Dam using the above infrastructure is shown in **Figure 6.1** below and are based on peak flow.

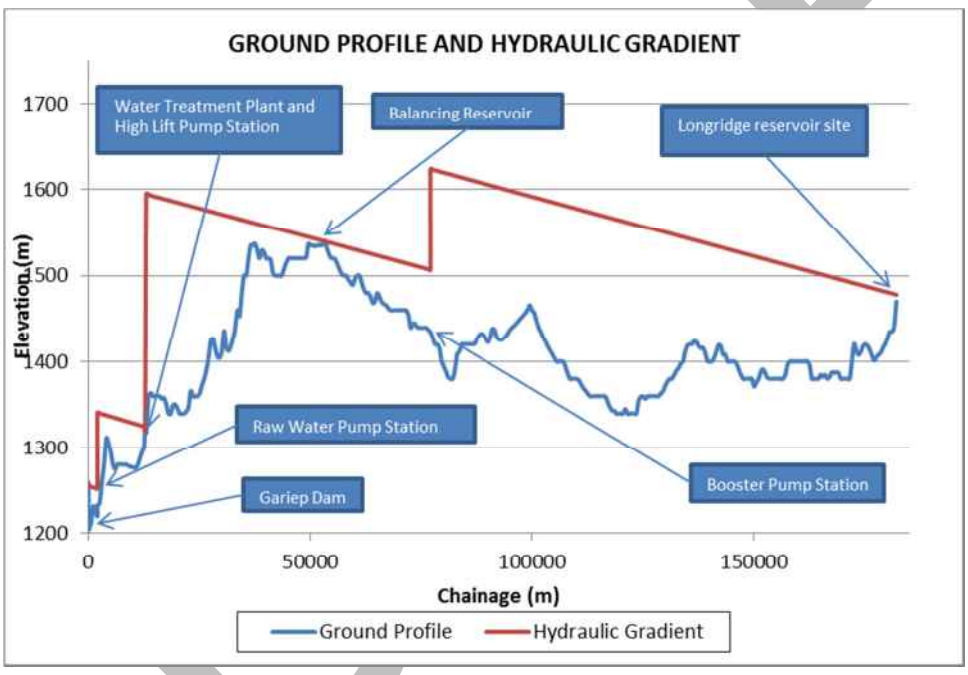


Figure 6.1 - Ground Profile and Hydraulic Gradient

6.3.4. Scheme Optimisation

Apart from the optimisation of the pipeline, which represents about half the CAPEX, the operating cost should also be optimised. This can be done by operating the system during off-peak periods and provide storage at high points to gravitate during off peak periods. By using the balancing reservoir as an off peak/balancing storage, significant energy cost savings can be realised. This aspect will be reported in the final TFS report.

6.3.5. Estimated Construction Costs

The estimated construction costs for the various infrastructure components are summarized in **Table 6.2** below. Costs are May 2015 based and include for 10% contingencies.

Component	Node	Phase 1	Ph1 + Ph2
Refurbishment of Dam Outlet and Suction Main	ABS01	R75 000 000	R 75 000 000
Raw Water Pump Station	PS1	R70 000 000	R 92 000 000
Raw Water Pipeline	GP1.1	R204 000 000	R 204 000 000
Water Treatment Plant and Balancing Reservoir	WT1 +RES1	R340 000 000	R 750 000 000
High Lift Pump Station	PS2	R180 000 000	R 238 000 000
High Lift Pipeline	GP1.2	R662 000 000	R 662 000 000
Balancing Reservoir (12hr @ peak)	RES2	R50 000 000	R 90 000 000
Booster Pump Station	PS3	-	R 171 000 000
Booster Pipeline	GP1.3	R1 944 000 000	R 1 944 000 000
Terminal Storage Reservoir	RES3	R45 000 000	R 45 000 000
Bulk Power Supplies		R30 000 000	R42 000 000
TOTAL (VAT excluded)		**R3 630 000 000**	**R 4 312 000 000**

Table 6.2 - Summary of Estimated Construction Costs

6.4. Mechanical Design and Engineering

6.5. Control & Instrumental Design

A provisional fibre optic and microwave communicator network layout was developed to ensure adequate control of all nodes along the pipeline corridor. Layouts of the fibre optic and microwave networks are attached under Annexure A.

6.6. Electrical Design

6.7. Value Engineering

6.8. Maintenance access and philosophy

6.9. Systems engineering design

6.9.1. Abstraction
6.9.2. Pumping
6.9.3. Transfer
6.9.4. Treatment
6.9.5. Storage
6.9.6. Off takes

PART IV – COST ESTIMATION, FUNDING AND STRUCTURING

7. CAPITAL COST ESTIMATE REPORT

7.1. Cost Summary, Accuracy and Basis of Estimate

A high level (Level 3) cost estimate was developed at an accuracy of +- 30%. Once detailed topographical and geotechnical have been done to inform the preliminary designs the estimates can be revised. It should be noted that the pipeline represents about 60% of the total project cost and the pipeline design therefore has a significant impact on the total project cost.

7.2. Estimating Methodology and cost Breakdown Structure (CBS)

The estimating methodology was based on a cost breakdown structure derived from the work breakdown structure. Costs were derived from unit costs of recently completed, pumping stations, water works, reservoirs and pipelines. Significant unknowns exist at this stage with regards to the geotechnical conditions and the costs associated with the power supply to the project. These costs will have to be quantified during the BFS stage.

7.3. Escalation and Forex Exposure

The cost base is May 2015 and the impact. The impact of rand value fluctuations and escalation has not been included in the cost estimate at this stage. The financial models will accommodate the impact of foreign currency fluctuations and escalation during the BFS stage.

7.4. Contingency Calculation

A 10% allowance was made for contingencies at this stage. Contingency allowance will be further refined during the BFS stage.

7.5. Capital Schedule / Cash Flow Forecasting

Table 7.1 indicates the CAPEX estimate for different pipeline sizes. The lowest life cycle pipe size is a 1300/1400 combination with a total estiamted CAPEX of R4.3 billion.

Cost summary (includes P&G's and 10% contingencies)	Pipe diameter			
	1300	**1400**	**1500**	**1600**
Refurbish dam outlet and suction	R 75 000 000	R 75 000 000	R 75 000 000	R 75 000 000
Raw water pump station - civil	R 40 000 000	R 30 000 000	R 30 000 000	R 30 000 000
Raw water pump station - M&E	R 67 843 952	R 61 872 018	R 57 983 316	R 55 413 996
Raw water PV installation	R 0	R 0	R 0	R 0
Raw water pipeline (CH0km to CH12.5km)	R 189 000 000	R 204 000 000	R 221 000 000	R 243 000 000
Water treatment plant - civil	R 432 000 000	R 432 000 000	R 432 000 000	R 432 000 000
Water treatment plant - M&E	R 288 000 000	R 288 000 000	R 288 000 000	R 288 000 000
WTP reservoir 20Ml - 2 hours at peak Q	R 30 000 000	R 30 000 000	R 30 000 000	R 30 000 000
High lift pump station - civil	R 55 000 000	R 55 000 000	R 55 000 000	R 55 000 000
High lift pump station - M&E	R 199 338 760	R 182 611 495	R 171 305 714	R 164 561 915
High lift PV installation	R 0	R 0	R 0	R 0
High lift pipeline (CH12.5km to CH53km)	R 611 000 000	R 662 000 000	R 718 000 000	R 787 000 000
Balancing reservoir 20Ml - 12 hours at peak Q	R 30 000 000	R 90 000 000	R 90 000 000	R 90 000 000
Pipeline (CH53km to CH182km)	R 1 944 000 000	R 2 104 000 000	R 2 283 000 000	R 2 520 000 000
Trompsburg pump station - civil	R 40 000 000	R 40 000 000	R 30 000 000	R 30 000 000
Trompsburg pump station - M&E	R 130 710 690	R 77 487 571	R 42 909 073	R 19 768 587
Trompsburg PV installation	R 0	R 0	R 0	R 0
Reservoir at Longridge 35Ml - 4 hours at peak Q	R 42 000 000	R 45 000 000	R 45 000 000	R 45 000 000
Total	**R 4 176 893 402**	**R 4 316 971 083**	**R 4 509 198 103**	**R 4 804 744 498**

Table 7.1 – CAPEX for Gariep Dam Augmentation Project for different pipeline sizes

A provisional cash low curve was calculated and is shown in Figure 7.1.

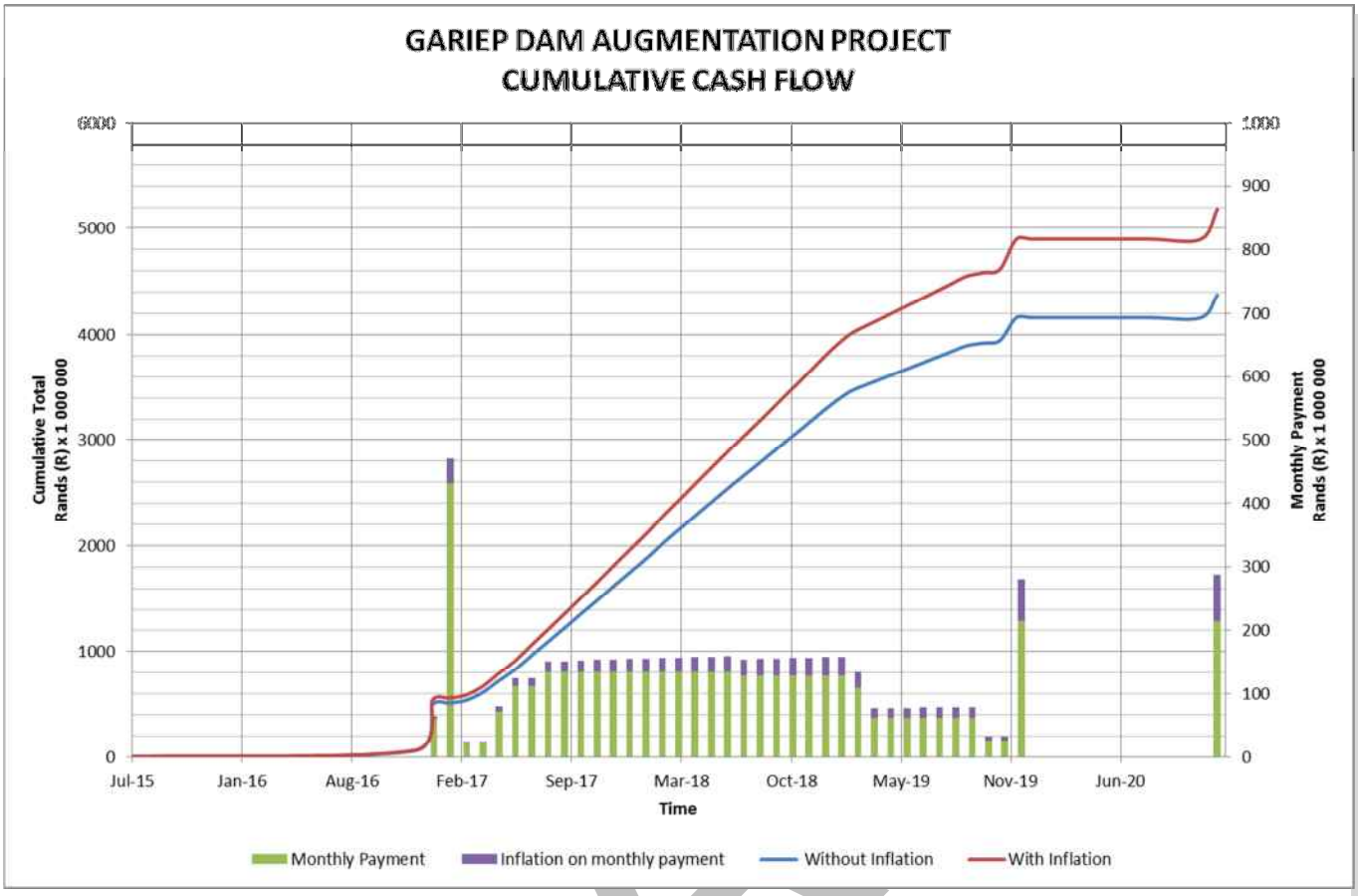


Figure 7.1 –Projected cash flow for Gariep Dam Augmentation Project assuming a 48 month construction period

8. OPERATING COST REPORT

8.1. Operational scenarios

The operating cost of the water supply systems, including the GAP is dependent on the operational scenario selected. The key challenge is to determine the optimal operating strategy; in keep operating costs as low as possible, maximise the income to MMM during the life time of the project and at the same time limit the tariff increases. Before these operating scenarios are described the following should be given as background information relating to operating cost of the various water sources.

8.1.1. Water resource operating cost

The operating cost[11] of a water supply system is determined by the cost of water, treatment cost, pumping cost, maintenance cost and personnel cost. The water tariff supplied by Bloem Water should reflect the operating cost. The operating cost of the GAP and Maselspoort WTW has been estimated and the details of this is attached as Annexure E. The following is worth noting regarding current water systems:

- MMM receives water from Bloem Water via Rustfontein WTW (predominantly Botshabelo and Thaba Nchu) and Welbedacht WTW (predominantly Bloemfontein). The water tariff for water supplied from Rustfontein and Weldbedacht WTW is currently R5.21/kl and increases annually in June.
- MMM treats water at its own WTW at Maselspoort. A stepped water tariff is in place for the raw water abstracted. For a total water abstraction less than 30% of the total water use, a raw water tariff of R3.83 is paybale to Bloem Water. For raw water abstraction exceeding 30% a raw water tariff equivalent to the Bloem Water potable water tariff is charged, i.e. R5.21. The potable water operating cost for water from Maselspoort WTW can therefore **currently** is about between R5.80/m^3 to R7.80/m^3. (refer to Annexure E for details O&M costs)
- It is envisaged that the water reuse arrangement will provide sufficient motivation for discarding the Bloem Water raw water tariff applicable to Maselspoort WTW. Assuming a much lower raw water tariff in line with the DWS raw water tariff of about R0.2/m^3 for the Modder river catchment the projected operating cost for the Maselspoort WTW is expected to reduce significantly to about R2.30/m^3. If it is argued that the reuse water is not natural runoff, but transferred by MMM a zero raw water rate should be applicable. This can reduce the Maselspoort O&M costs to R2.10/m^3.
- In future it is envisaged that water could also be supplied from the Gariep dam by MMM. The anticipated O&M cost for the GAP is about R3.50/m^3.

8.1.2. Energy cost associated with use of different water resources

All the water resources require a significant portion of energy to transfer the water between the point of abstraction and the Bloemfontein distribution system. By assessing the pumping head required for the different options the energy required to operate these systems can be determined. The higher the pumping heads of the water supply option the larger the proportion attributable to energy cost as a fraction of the overall operating cost.

[11] *For the purposes of this exercise the cost of financing is excluded.*

Typicallly for a 100 Ml/d scheme the following fractions are applicable at an ESKOM tariff of R0.75/kWh:

- 300m pumping head – 40% energy cost as a portion of total O&M cost
- 500m pumping head – 50% energy cost as a portion of total O&M cost
- 700m pumping head – 60% energy cost as a portion of total O&M cost[12]

The scheme specific energy and O&M costs are shown in Annexure E.

8.1.3. Water resource operating scenarios

The following operating scenarios were considered in order to establish a range of **peak transfer requirements** for the Gariep system. A 7 day peak factor[13] of 1.4 was considered appropriate for the purpose of this feasibility study. Calculations for each of the water balance scenarios are included in Annexure B.

1) **Scenario 1** – Bloemfontein demand supplied from Maselspoort and Welbedacht in a 50:50 split and the deficit supplied from Gariep
2) **Scenario 2** – Bloemfontein demand supplied pro-rata to rated capacity from Maselspoort, Welbedacht and Gariep
3) **Scenario 3** – Bloemfontein demand supplied from Maselspoort and Gariep in a 50:50 ratio and the deficit is supplied from Welbedacht
4) **Scenario 4** – Bloemfontein demand supplied pro-rata to rated capacity from Maselspoort and Welbedacht and deficit from Gariep

If the case of **average transfer requirements** the same scenarios as above were considered, but the outcome was slightly different. Cases 4 and 5 reduced to the same operating scenario in the case of average demands. Cases 3, 4 and 5 all required no transfer from Welbedacht until 2035.

1) **Scenario 1** – Bloemfontein demand supplied from Maselspoort and Welbedacht in a 50:50 split and deficit is supplied from Gariep
2) **Scenario 2** – Bloemfontein demand supplied pro-rata from Maselspoort, Welbedacht and Gariep
3) **Scenario 3** – Bloemfontein demand supplied from Maselspoort and Gariep in a 50:50 split and deficit from Welbedacht
4) **Scenario 4** – Bloemfontein demand supplied pro-rata from Maselspoort and Gariep

The demand graphs for the various scenarios are shown in Figures 8.1 to 8.8 The dotted(solid) **black** line represents the 1%(2%) growth scenario after accounting for the VIP eradication, new developments and initial stages of WCDM programmes. The shaded blue/brown/green/purple areas represent the supply from Welbedacht/Rustfontein/upgraded Maselspoort and the future GAP systems respectively.

It is clear that in the case of **Scenario 1** that the current systems are fully utilised during average consumption (figure 8.1) before the GAP contributes towards the supply. During peak demand GAP will contribute from 2019.

[12] *this can increase to 75% if the ESKOM energy tariff increases to R1.5/kWh*

[13] *Measurements are currently being conducted by MMM to confirm the 7 day peak demand.*

This Scenario will not be an effective use of capital and require the GAP to be sized at about 200 Ml/d of which only about 30 Ml/d will be used during average demand periods (figure 8.2).

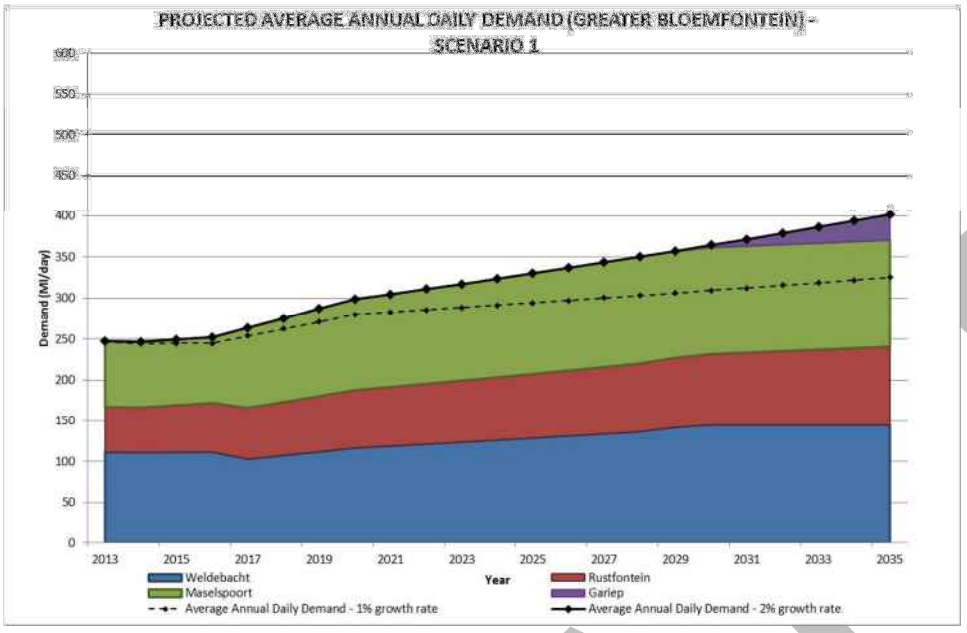


Figure 8.1 – Greater MMM water resource operating Scenario 1 (AADD)

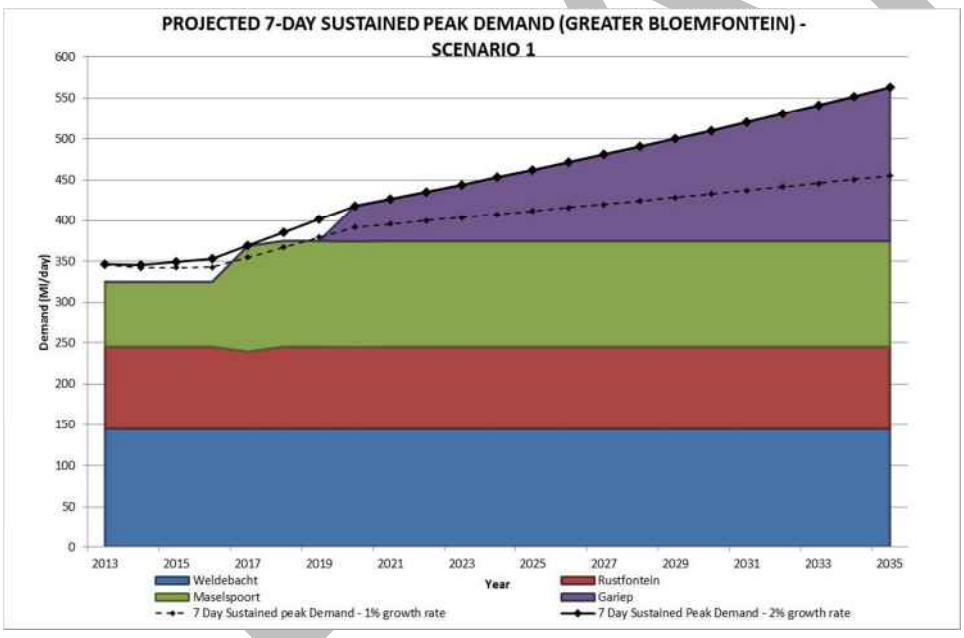


Figure 8.2 – Greater MMM water resource operating Scenario 1 (7-day peak)

In the case of **Scenario 2** the utilisation from all the existing and new sources are split on a pro-rata basis. The contribution of the GAP during peak demand periods increase towards the end of the design horizon (figure 8.4). The GAP needs to be implemented by 2019 to meet peak demand based on the 1% growth scenario. This scenario will be a better utilisation of capital and requires the GAP to be sized at about 200 Ml/d of which up to 100 Ml/d will be used during average demand periods.

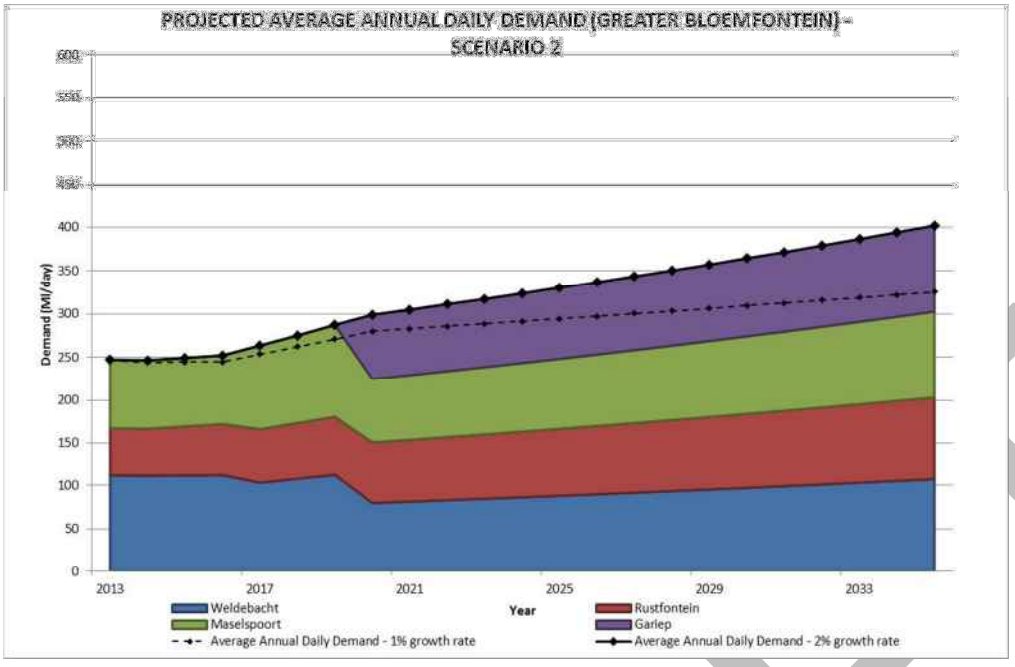


Figure 8.3 – Greater MMM water resource operating Scenario 2 (AADD)

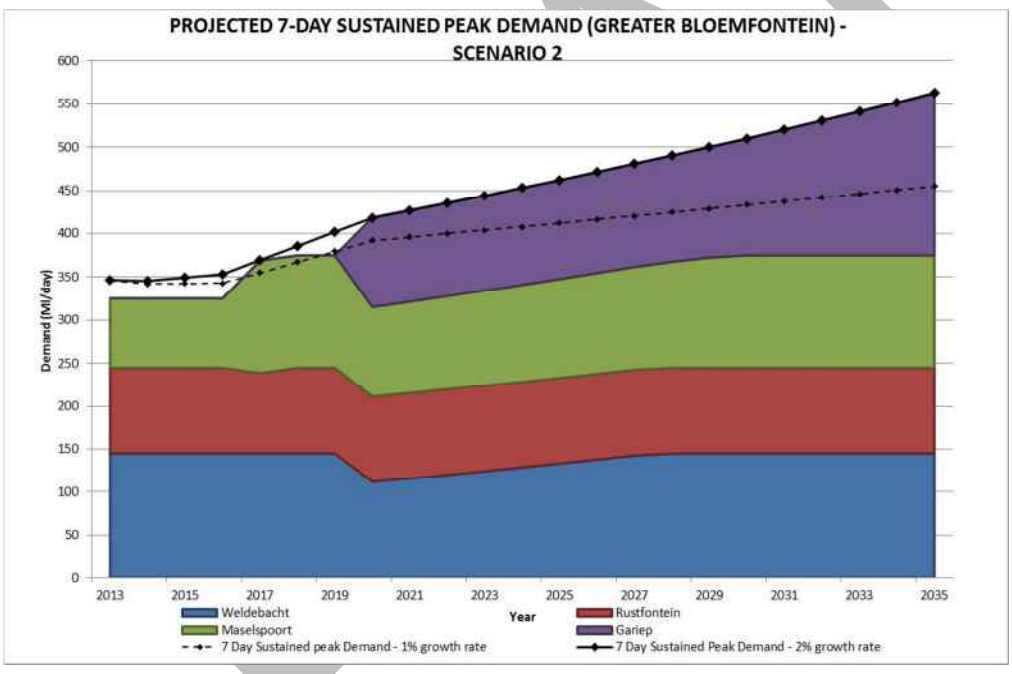


Figure 8.4 – Greater MMM water resource operating Scenario 2 (7-day peak)

In the case of **Scenario 3** the utilisation of Welbedacht WTW is limited to only supplying peak demand (figure 8.5). The contribution of the GAP during peak demand periods increase towards the end of the design horizon (figure 8.6). The GAP needs to be implemented by 2019 to meet peak demand based on the 1% growth scenario. This scenario will be a better utilisation of capital of the GAP. The GAP needs to be sized at about 200 Ml/d of which up to 170 Ml/d will be used during average demand periods. This option does, however, leave Welbedacht effectively as a peak demand supply facility from 2022.

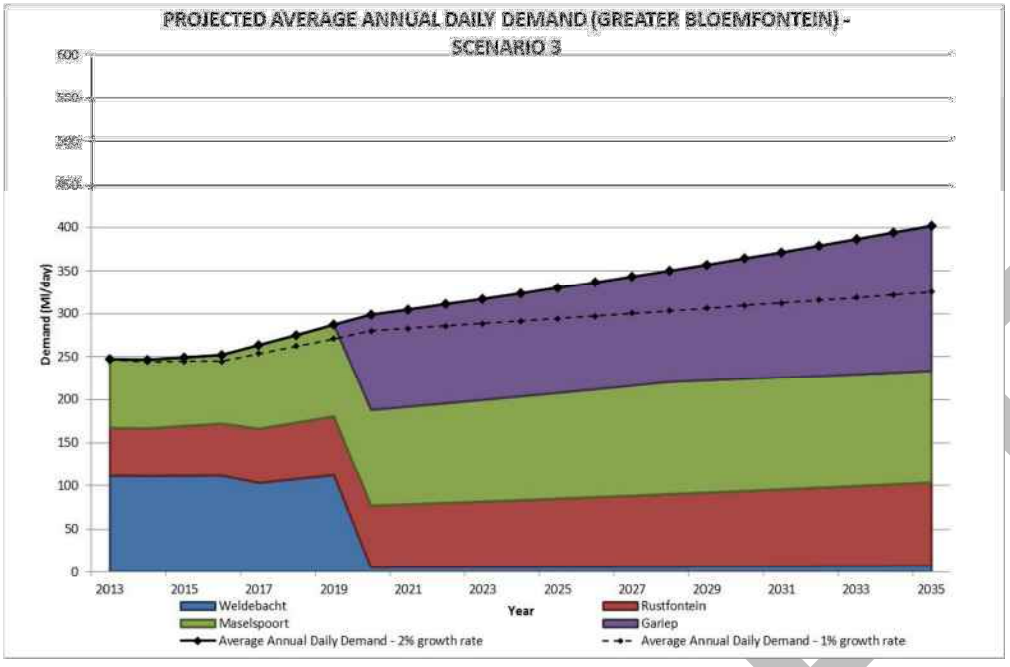


Figure 8.5 – Greater MMM water resource operating Scenario 3 (AADD)

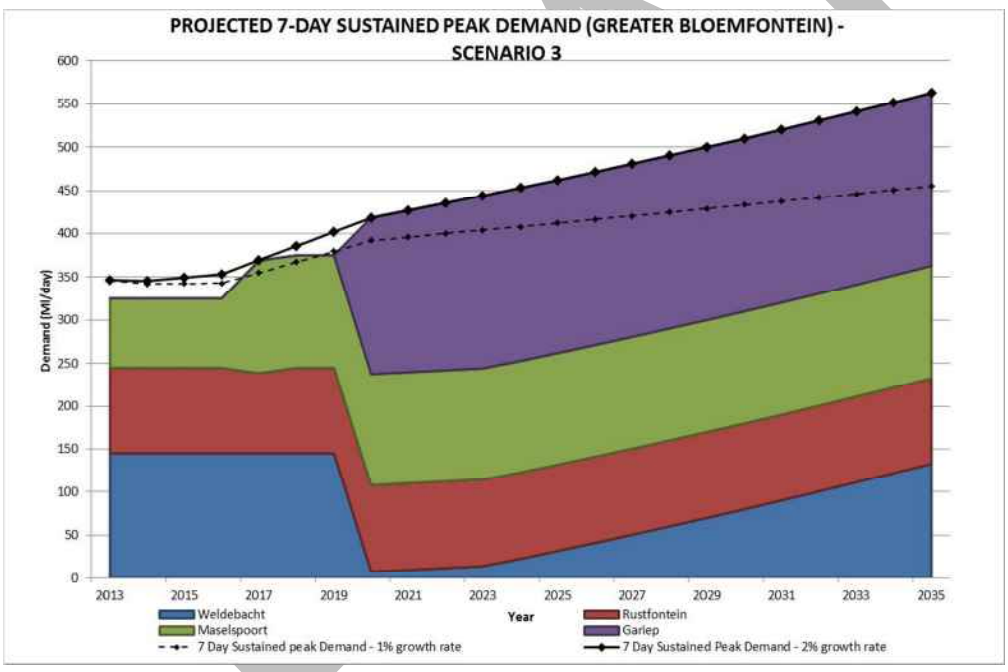


Figure 8.6 – Greater MMM water resource operating Scenario 3 (7-day peak)

In the case of **Scenario 4** the utilisation of Welbedacht WTW is limited even more. The contribution of the GAP during peak demand periods increase towards the end of the design horizon. The GAP needs to be implemented by 2019 to meet peak demand based on the 1% growth scenario. Scenario will be a better utilisation of capital of the GAP. The GAP needs to be sized at about 290 Ml/d of which up to 290 Ml/d will be used during average demand periods (figure 8.7). This option does, however, leave Welbedacht effectively

decommissioned with a small peak demand supply from 2022 and requires a significant amount of additional capital for the GAP.

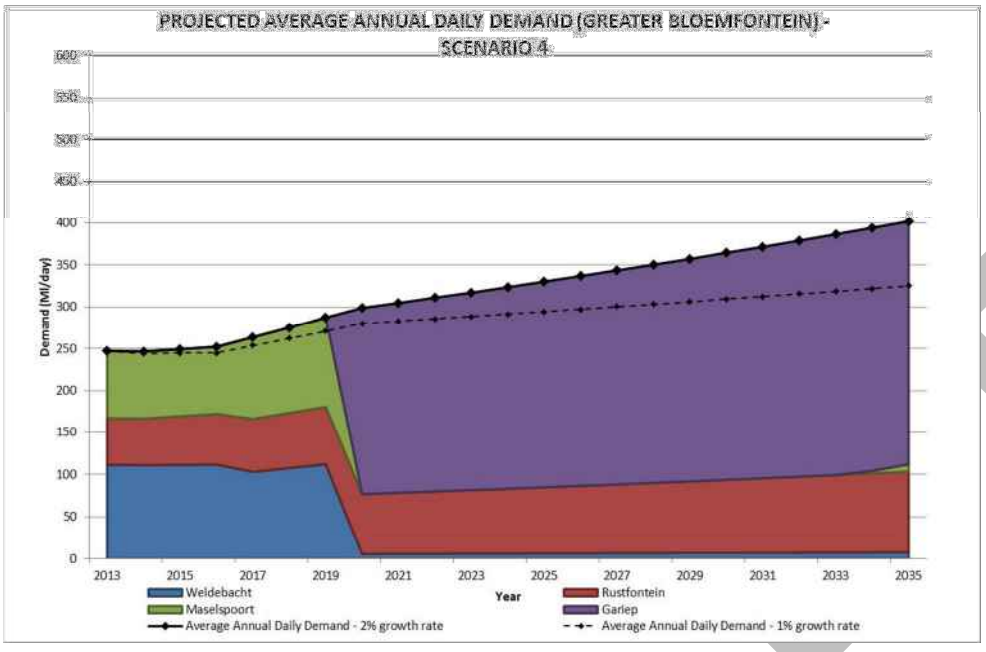


Figure 8.7 – Greater MMM water resource operating Scenario 4 (AADD)

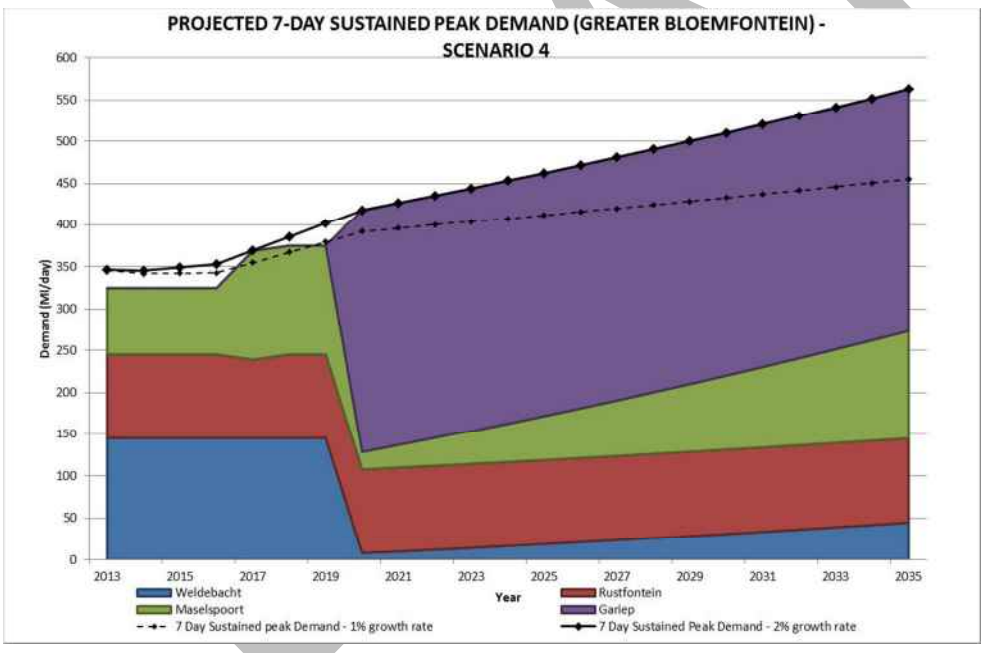


Figure 8.8 – Greater MMM water resource operating Scenario 4 (7-day peak)

8.1.4. Life cycle O&M cost comparison of various operating scenarios

By simply assessing the volume of water treated and transferred by each source it is not possible to identify the most cost effective solution. In order to achieve this a detailed life cycle O&M cost analysis had to be developed for each operating scenario. A summary of the life cycle costs for the four operational scenarios are discussed later in section 8. The detailed calculations of the life cycle O&M cost analysis can be found in Annexure E.

In order to maximise the income to MMM (required to repay capital) it is therefore essential that the lowest life cycle cost source be used at maximum capacity for as long as possible,i.e. a base load operating scenario. The low operarting cost systems should be prioritised and the most expensive sources should be used as a last resort. If the Gariep system is considered as a stand alone system it would make sense to operate the Gariep system as a base load system to maximise its utilisation and enable loan repayment. However, if all the sources are viewed as part of an integrated water resource base, the picture changes and the lowest cost source, operated at maximum capacity could potentially cross-subsidise the more expensive systems. This opportunity will not exist if the individual systems are operated by an external party such as Bloem Water.

8.2. Basis and Accuracy of Estimate

Annexure E contains a detailed operating cost model for each of the water supply systems and each of the operational scenarios. The structure and basis of the operating cost estimate is briefly discussed in this section. The accuracy of the operating and maintenance estimate is +-30% with a base date of May 2015.

8.3. Raw water costs

Each water supply system abstracts from a different source. According the DWS website the following Water Resource Infrastructure (WRI) and Water Resource Management (WRM) tariffs apply for F2015.

- Raw water tariff charged by Bloem Water from Modder river = R3.80/m^3
- Caledon River - R0.1768/m^3 plus R0.02/m^3 = R0.1968/m^3
- Modder river via Caledon river transfer - R0.1768/m^3 plus R0.02/m^3 = R0.1968/m^3
- Gariep Dam - R0.1815/m^3 plus R0.02/m^3 = R0.2015/m^3
- Water abstracted from WwTW effluent = R0.0/m^3

It is interesting to note that Bloem Water charges MMM a much higher raw water tariff than the tariff published by DWS for water abstraction from the Modder River. It was assumed that effluent intercepted at the North Eastern and Bloemspruit WwTW will be charged at a zero rate as it has not been discharged into the environment yet.

Each system includes unique values for treatment and transfer losses and these losses need to be compensated by increased raw water abstraction. The Gariep system, for instance, allows for a 5% additional raw water abstraction fraction of 1.05 was therefore included as shown in Table 8.1.

8.4. Energy cost

The energy cost for each system was based on the pumping heights at the duty point and the required flow for that specific year. Allowances were made for transfer and treatment losses. A unit tariff of R0.75/kWh was assumed. A pumping efficiency of 80% was assumed for all pumpsets. This was derived by assuming a pump efficiency of 85% and a motor efficiency of 95%. The unique topography and system layout determines the pumping head and these are detailed in Annexure G. In Table 8.1 the pumping heads for the Gariep system for instance is indicated as 82m+208m+92m. Also in Table 8.1 it is indicated that an additional 5%, a factor of 1.05, is required for treatment losses.

8.5. Treatment cost

The treatment cost depends on the raw water quality that needs to be treated. The raw water type was assessed and appropriate chemical dosing costs were calculated for polymer, lime, chlorine and in the case of Maselspoort granular activated carbon and liquid oxygen. The chemical dosing cost was calculated as the product of the annual production rate, dosing rate and unit cost of treatment chemicals.

8.6. Maintenance cost

The maintenance cost is always challenging to assess. The reason for this is there is a huge range between the cost that should be allocated for sustainable and un-sustainable maintenance. In the first instance sufficient cost is allowed for proper preventative maintenance and in the second case equipment is not maintained at all and are operated until failure. Best practise, however, requires that a certain percentage of capital value be invested in maintenance. For the purpose of this report, the best practise guidelines of DWS was applied, i.e. 0.5% for pipeline infrastructure, 1% for civil infrastructure and 4% for mechanical and electrical infrastructure. The total annual maintenance cost was estimated as a percentage of the system asset value.

8.7. Employment cost

As all the treatment schemes are more or less the same order of magnitude (100-200 Ml/d) the same employment cost was assumed for all systems. The total cost of R7m per annum comprised of management, operation, laboratory services, admin and maintenance staff.

8.8. Inflation rate

As all the operating cost items do not escalate at the same rate a relative inflation was determined for each system in terms of raw water cost, energy, chemicals, maintenance and salaries. A separate escalation rate was also allowed for the Bloem Water tariff. For comparison purposes only two items were escalated above inflation; energy cost (5% above inflation) and Bloem Water tariff (2.5% above inflation).

8.9. Finance cost

The finance cost was excluded from the O&M cost estimation. The reason for this was that the O&M cost savings are intended to be used for gearing and funding of capital investments in new infrastructure. The financial model discussed in section 10 will deal with the financing cost.

8.10. Structure of the Estimate

The operating and maintenance cost was established for each water supply system and include fixed and variable cost items. The variable cost items include; raw water cost, energy cost and treatment cost. The fixed cost items include; maintenance cost, laboratory cost and salaries. A unit rate was determined for the variable cost in R/kl. The total annual operating cost was determined by adding the fixed annual costs plus the unit variable cost multiplied by the volume of water transferred during a particular year of operation. This process was repeated for the entire project period from 2015 to 2035. Figure 8.1 shows and extract of the O&M costs calculations for the period 2019-2022 of the Gariep system. (Note that the Gariep system is only expected to be

on line in 2019. Detailed O&M cost calculations for the Gariep, Welbedacht, Rustfontein, Maselspoort (current) and Maselspoort (with water reuse) are attached as Annexure E. Cells highlighted in yellow represent cells where model units are required.

	Operating cost element					Year										
						2 015	2 016	2 017	2 018	2 019	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027
						Annual operating cost												
	System capacity			Water use efficiency factor	Above inflation factor					100	104	108	112	117	122	127	132	137
Gariep system	Raw water																	
	Gariep dam	0.2	R/m3	1.05	1					7 665 000	7 971 600	8 290 464	8 622 083	8 966 966	9 325 644	9 698 670	10 086 617	10 490 082
	Energy																	
	Raw water PS	82	m	1.05						8 012 432	8 332 929	8 666 246	9 012 896	9 373 412	9 748 348	10 138 282	10 543 813	10 965 566
	High lift PS	268	m	1						24 939 973	25 937 572	26 975 075	28 054 078	29 176 241	30 343 291	31 557 022	32 819 303	34 132 075
	Booster PS	92	m	1						8 561 483	8 903 943	9 260 100	9 630 504	10 015 725	10 416 354	10 833 008	11 266 328	11 716 981
	Total	0.75	R/kWh		1.05					50 460 391	55 102 747	60 172 199	65 708 042	71 753 181	78 354 474	85 563 086	93 434 890	102 030 899
	Treatment	mg/l	R/kg															
	Lime	60	2.8		1													
	Poly	10	15		1					0.19								
	Chlorine	10	22		1													
	Total									19 637 000	20 422 480	21 239 379	22 088 954	22 972 513	23 891 413	24 847 070	25 840 952	26 874 590
	Maintenance & Transport	Capital split	% maintenance															
		70%	0.50%		1					15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000
	Total CAPEX	15%	1%		1					3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000
		15%	4%		1					25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000
		4 300 000 000								**44 075 000**	**44 075 000**	**44 075 000**	**44 075 000**	**44 075 000**	**44 075 000**	**44 075 000**	**44 075 000**	**44 075 000**
	Grant funding	3 200 000 000																
	Salaries	7 000 000			1					7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000
	Total O&M cost									128 837 391	134 571 827	140 777 042	147 494 079	154 767 660	162 646 532	171 183 826	180 437 459	190 470 572
	Unit variable cost		R/kl							2.13	2.20	2.27	2.35	2.43	2.51	2.60	2.69	2.79
	Unit O&M cost		R/kl							3.53	3.55	3.57	3.59	3.62	3.66	3.71	3.76	3.81
	Finance cost	Int. rate	8%							110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089
	Total O&M and finance cost		1							239 247 480	244 981 916	251 187 132	257 904 168	265 177 749	273 056 621	281 593 915	290 847 548	300 880 661
	Unit rate		R/kl							6.55	6.45	6.36	6.28	6.21	6.15	6.10	6.06	6.02

Table 8.1 – Extract from O&M cost calculation – Gariep system

During a previous section a number of operational scenarios were assessed and it was established that various combinations of four water supply systems will be utilised. The O&M cost for each system was subsequently determined as per the operation rules for Scenarios 1 to 4. An example of the combined operational cost for Scenario 1 is shown in Figure 8.2. The total O&M life cycle cost for the 2015-2035 period is also calculated.

Scenario 1 (50% split between Welbedacht and Maselspoort, Gariep shortage)	Total AADD		249	252	264	275	287	299	305	311	317	324
	Gariep	AADD						4	6	8	11	13
		Fixed cost						51 075 000	51 075 000	51 075 000	51 075 000	51 075 000
		Variable cost						3 122 658	5 113 220	7 274 081	9 619 724	12 165 799
		Total cost						54 197 658	56 188 220	58 349 081	60 694 724	63 240 799
	Maselspoort (curre	AADD	96	96	100	105	109	110	110	110	110	110
		Fixed cost	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000
		Variable cost	52 345 530	53 754 663	57 686 345	61 875 367	66 340 708	68 674 527	70 642 779	72 709 442	74 879 440	77 157 937
		Total cost	67 545 530	68 954 663	72 886 345	77 075 367	81 540 708	83 874 527	85 842 779	87 909 442	90 079 440	92 357 937
	Welbedacht	AADD	96	96	100	105	109	114	116	118	121	123
		Fixed cost	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375
		Variable cost	58 969 259	60 406 930	64 664 830	69 189 253	73 999 568	79 116 586	82 807 524	86 721 600	90 873 867	95 280 432
		Total cost	91 568 634	93 006 305	97 264 205	101 788 628	106 598 943	111 715 961	115 406 899	119 320 975	123 473 242	127 879 807
	Rustfontein	AADD	58	61	63	66	68	71	73	74	75	77
		Fixed cost	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500
		Variable cost	45 438 144	48 910 646	52 627 865	56 608 199	60 871 428	65 438 814	69 036 090	72 867 794	76 950 153	81 300 534
		Total cost	71 400 644	74 873 146	78 590 365	82 570 699	86 833 928	91 401 314	94 998 590	98 830 294	102 912 653	107 263 034
	Total Annual system cost		230 514 807	236 834 114	248 740 914	261 434 694	274 973 579	341 189 459	352 436 487	364 409 792	377 160 058	390 741 577
	Total O&M life cycle cost		8 582 516 145									

Table 8.2 - Example operational scenario O&M cost calculation

Comparing the various scenarios on this basis enable MMM to assess which operation scenario provides the best opportunity for cost savings. By comparing the three scenarios it became evident that Scenario 4 is not a practical solution as it will increase the size of the Gariep system to 300 Ml/d while at the same time leave existing systems non-operational. The life cycle O&M cost was compared from two different bases; a base where the current Bloem Water tariffs were assumed for the Welbedacht and Rustfontein WTW and current raw

water tariff for Maselspoort (Table 8.3) and a base where O&M costs were inferred from first principles (Table 8.4).

From table 8.3 it is clear that scenario 1 has the lowest O&M cost and largest potential saving. The reason for this is the low utilisation of the new Gariep system. This is not desirable from an efficient use of capital perspective and future funders will most probably require a much higher utilisation from this new scheme. Scenario 2 is a close second and most probably the most equitable and acceptable uptake arrangement of the four different schemes.

Ranking	Scenario	Total O&M life cycle cost	Total O&M life cycle saving
4	Status quo	17 735 251 164	-
1	Scenario 1	8 582 516 145	9 152 735 019
2	Scenario 2	8 875 002 908	8 860 248 256
3	Scenario 3	10 592 369 928	8 709 192 247

Table 8.3 – O&M scenario comparisons for the case where inferred Bloem Water tariffs are assumed

The lowest O&M cost from table 8.4 is scenario 3b which is as a result of significant reduction in water supplied from Welbedacht at current Bloem Water rates. A complete decommissioning is probably not the ideal solution. Scenario 2b, currently second best, is a more equitable and acceptable uptake and if further optimised can reduce costs even further.

Ranking	Scenario	Total O&M life cycle cost	Total O&M life cycle saving
4	Status quo	17 735 251 164	-
3	Scenario 1b	13 943 091 928	3 792 159 236
2	Scenario 2b	12 974 612 458	4 760 638 707
1	Scenario 3b	10 592 369 928	7 142 881 236

Table 8.4 – O&M scenario comparisons for the case where current Bloem Water tariffs are assumed

In both cases operation scenario 2(2b) appears to offer the most scope for equitable and cost effective uptake from the four water supply systems. If Bloem Water were to continue to exist as an independent water service provider, scenario 2b could therefore the most likely operational scenario. Operational scenario 2b can be further refined during the BFS stage. At this stage a simplified 33/33/33 split was assumed between Welbedacht/Maselspoort and Gariep systems. The consumption from Rustfontein was dedicated to the demand from Botshabelo and Thaba Nchu. A further refinement could be to reduce the total operating cost from Rustfontein by using more water from Welbedacht, Maselspoort and Gariep. Either way significant life cycle O&M cost savings can be realised through the introduction of the GAP and Maselspoort reuse. These savings can be utilised to fund capital upgrades at both GAP and Maselspoort.

9. MARKET ANALYSIS, CONSUMER DEMOGRAPHICS AND PRICING REPORT

This section will be expanded in the final TFS report and completion of MMM tariff assessment by E&Y and will address:

9.1. Demand Forecasts
9.2. Supply Forecasts
9.3. Impact of WCDM initiatives
9.4. Pricing Strategy
9.5. Revenue Forecasts

10. FUNDING AND FINANCIAL MODELLING REPORT

This section will be expanded in the final TFS report and completion of MMM tariff assessment by Cresco and will address:

10.1. Potential funding sources
10.2. Funding portfolio scenarios
10.3. Financial modelling approach
10.3.1. Key Assumptions and project variables
10.3.2. Capital Estimate
10.3.3. Operating Cost Estimate
10.3.4. Taxation
10.3.5. Scenario analysis
10.3.6. Evaluation criteria
10.4. Financial modelling results
10.4.1. Cost of capital
10.4.2. Water tariffs
10.4.3. Cross subsidisation
10.4.4. Sensitivity analysis
10.4.5. Affordability
10.4.6. Value for money assessment
10.4.7. Benchmarking
10.5. Financial modelling recommendation

11. PROJECT STRUCTURING OPTION ANALYSIS REPORT

This section will be expanded in the final TFS report and completion of MMM tariff assessments.

11.1. Service delivery options

A water services authority can decide to perform the various water services provider functions in house or contract a service provider to perform these functions. MMM has appointed Bloem Water as a water services provider for water supply to Thaba Nchu, Botshabelo and parts of Bloemfontein as a result of historical developments. MMM now has to decide if the new infrastructure that is planned to be developed under GAP is to be provided through an internal mechanism or an external mechanism. The internal and external mechanisms available to MMM are discussed in more detail below and some model structures are attached as Annexure I.

11.2. Internal service delivery options

11.2.1. Municipal entity
11.2.2. Another Municipality
11.2.3. Organ of state in terms of WSA
11.2.4. Organ of state in terms of national legislation (Water Board)

11.3. External service delivery options and legal requirements

11.3.1. General principles

External service delivery models often involve the private sector. Private sector intends to limit risk to the minimum and for that reason the following basic principles should be applied when considering and external service delivery route:

- Ring-fenced projects with clearly defined points of transfer and battery limits
- Limited recourse project finance basis to reduce financial risk of the lenders
- Clearly defined off-taker(s) and off-takes to quantify income stream
- Appropriate operation, maintenance and management structures
- Phased project development (preparation, implementation and O&M)
- Development of various agreements eg. Administration Agreement, Professional Services Agreement, Loan Agreement, Water Services Agreement, Operating and Maintenance Agreement, Lease Agreement

11.3.2. Special purpose vehicles (SPV)
11.3.3. Ring fenced PPPs
11.3.4. Legal requirements for external service delivery

A number of legal aspects have to be considered if the external mechanism is to be followed. Only two of the legal processes that need to be followed are described below, i.e. the section 78 of MSA process and the section 192 of LRA process.

a) Section 78 of MSA requirements

Given the tight time frame requirements imposed on the execution of the Bankable Feasibility Study as part of the Project Preparation Phase, certain of the statutory processes are currently on the critical path of the implementation programme. Currently, these processes include the following:

- Section 78 of the Municipal Structures Act:
  - The current status of the MMM Section 78 process needs to be adjusted in respect of bulk water supply envisaged from GAP to provide the service through an external mechanism. The same process will have to be followed if the intention is for Maselspoort to be implemented through an external mechanism as well.
  - If is envisaged to include the internal water and sanitation services to form part of external mechanism the reticulation services, MMM needs to update and amend the Section 78 report to provide for the internal water service to be provided through an external mechanism;
  - As part of the Section 78(3) process, MMM should approve a feasibility study that addresses and satisfies specific requirements as indicated in this section of the Act.

As indicated above, Section 78(3)(c) of the MSA calls for a feasibility study to be conducted and taken into account by a municipality as part of the Section 78 process. The specific requirements for the feasibility study as stipulated in Section 78(3) (c) are as follows:

1. A clear identification of the **municipal service** for which the municipality intends to consider an external mechanism; (in the case of GAP this will be bulk water transfer and treatment)
2. An indication of **the number of years** for which the provision of the municipal service through an external mechanism might be considered; (this period will be for at least the term of the loan and even longer)
3. The projected **outputs** which the provision of the municipal service through an external mechanism might be expected to produce;
4. An assessment as to the extent to which the provision of the municipal service through an external mechanism will –
   i. Provide **value for money**;
   ii. Address the **needs of the poor**;
   iii. Be **affordable** for the municipality and residents; and
   iv. **Transfer** appropriate technical, operational and financial **risk**;
5. The projected **impact** on the municipality's **staff, assets and liabilities**;
6. The projected **impact** on the municipality's **integrated development plan**;
7. The projected **impact** on the municipality's **budgets** for the period for which an external mechanism might be used, including impacts on **revenue, expenditure, borrowing, debt and tariffs**; and
8. Any other matter that may be prescribed.

b) Section 197 of LRA

As explained in this document, the establishment of a ring fenced entity is a requirement for the successful raising of project finance and will inter alia be responsible for the effective operation and maintenance of the

infrastructure associated with the project. Should an existing municipal service be upgraded, incorporated and extended the question arises as to the future of municipal staff employed to render the current service.

Two broad scenarios exist for accommodating staff affected by the project. Firstly; secondment whereby staff will remain employed by the Municipality, substantially within the same conditions of service, collective bargaining and pension fund structures. Secondly; transfer of employment within the ambit of section 197 of the Labour Relations Act (as amended) that provides for the transfer of individual contracts of employment. In the event that a transfer of employment is contemplated in terms of the provisions of section 197, an employee has to be transferred to a new employer on terms and conditions on the whole not less favourable than that at the old employer. It is important to emphasise that practical adjustments may be made through a formal agreement in terms of section 197(6) of the Act to conditions of employment within the provision that it must remain not less favourable to the employee.

Both the secondment and transfer routes hold benefits and disadvantages. While a secondment is procedurally less complicated it could maroon management and support staff at the old employer with a subsequent liability to the old employer. On the other hand the provisions of section 197 of the Labour Relations Act, the new employer will inherit any contingent liability associated with a contract of employment unless specifically agreed to share such a liability between new and old employers. Typically, within a Municipal environment, such liabilities could relate to unfunded future medical aid liabilities, accrued leave and special pension fund provisions etc.

a. Contractual forms and legal entities

i. Service contract
ii. Management contract
iii. Lease contract
iv. Concession
v. BOT/BOOT
vi. Sale of assets

b. Service delivery mechanism option comparison

c. Service delivery risk matrix

d. Service delivery decision matrix

e. Service delivery recommendation

f. Statutory processes

The following statutory processes have been identified to date:

- Section 78 (in terms of MSA) process for external bulk water and distribution services
- Section 192 (in terms of LRA) process for transfer of MMM personnel
- Updating of IDP, WSDP, MTREF, BEP and WCDM planning reports

- Section 21 (in terms of WSA) process for application of water uses from Gariep dam
- ….
- ….

g. Development of legal documentation for GAP

There are a number of legal agreements that will have to be developed to incorporate and external water services provision mechanism. These agreements will be developed during the BFS stage once a project underwriter has been identified:

i. The Administration Agreement
ii. The Professional Services Agreement
iii. The Loan Agreement
iv. The Water Services Agreement

The relationship between the newly established external mechanism and MMM as the only beneficiary is governed in terms of the:

- Companies Act;
- Municipal Finance Management Act ("MFMA"); and
- Municipal Systems Act ("MSA").

The Water Services Agreement (as amended) governs the commercial relationship between MMM and the external party and specifically regulates the services rendered by the external party to MMM, payment for such services, etc. This agreement is primarily governed by the Water Services Act. In terms of the Water Services Agreement the services need to be described and the

i. The Off-take Agreements
ii. The Operating and Maintenance Agreement
iii. Other agreements

PART V – EXECUTION AND SUPPORT

12. PROJECT EXECUTION PLAN

12.1. Project scope

The project scope of the Gariep dam Augmentation Project includes all components required to abstract, pump, treat to potable standards, store and transfer from Gariep dam to a bulk storage reservoir in Bloemfontein. The components of the GAP is shown in work breakdown structure in Figure 12.1.

12.2. Project Work breakdown structure

Figure 12.1 – GAP work breakdown structure

Key non-technical activities include the financial modelling, structuring of funding and structuring of development and implementation models. These aspects will be addressed in more detail during the BFS phase.

12.3. Project development stages

The project could be developed in these distinct stages; The project preparation stage, the project procurement stage and the project implementation stage. The **project preparation stage** includes the aspects related to the setting up of project structures, the sourcing of project funding and the completion of the feasibility study phases. Key milestones include the following:

- Pre-feasibility study completed – November 2014
- PSP team for feasibility study phases assigned and appropriately structured – January 2015
- Technical feasibility (first draft) study completed – May 2015
- Revise TFS and Commission BFS study team – June 2015
- Commission specialist investigations, site surveys and authority approvals – June 2015
- Project underwriter(s) secured – October 2015
- Project structure agreed – November 2015
- Bankable feasibility study completed (with conditions precedent for long lead items) – December 2016

The **procurement stage** involves the development of procurement documentation and identifies the preferred bidder. Milestones include:

- Procurement documentation completed – September 2015
- Pre-qualification completed – October 2015
- Closing of bid documents – December 2015
- Preferred bidder notice – January 2015

The **implementation stage** ensure that the contractor constructs, commissions, hands over (and in some case operate) the infrastructure. Milestones include:

- Notice to proceed with construction – January 2016
- Approval of project management plan – February 2016
- Approval of designs – April 2016
- Commissioning completed and delivery of first water – November 2019
- Trial period completed and hand over – February 2020

12.4. Base schedule

A preliminary base schedule is attached in Annexure G. The schedule will be updated once the funding and structuring models have been finalised. This aspect will be addressed in the final TFS version.

13. HUMAN RESOURCES REPORT

This section will be expanded in the final TFS report and completion of MMM tariff assessment by Cresco and include:

13.1. Labour planning
13.2. Organogram
13.3. Training / Skills Requirements /CSI
13.4. Transformation and local economic participation

14. LEGAL AND REGULATORY REPORT

This section will be expanded in the final TFS report and completion of MMM tariff assessment by E&Y and will include:

14.1. Legal and Regulatory Compliance

i. Municipal finance and structures Act requirements
ii. Labour relations Act
iii. NEMA
iv. Water Services Act
v. National Water Act

14.2. Authority Approvals

i. Power supply
ii. Power generation
iii. Water Use Licences
iv. Water abstraction point modifications and approvals
v. Environmental assessments and authorisations
vi. Land use, servitudes, valuation, compensation and registration
vii. Other permits and licenses

15. SAFETY, HEALTH, ENVIRONMENT & COMMUNITY REPORT

15.1. Safety and Health Risk Assessment

In terms of the Occupational Health and Safety Act's, No 85 of 1993 (OHSA) Construction Regulations, Mangaung Metropolitan Municipality is required to implement a compliance management system for each construction project it undertakes. The objective of the proposed management system is to facilitate compliance with the OHSA and in specific the requirements of the Construction Regulations as far as this construction project is concerned.

Construction Regulation 5 (1) (b) requires Mangaung Metropolitan Municipality to compile an occupational health and safety specification for each project and the principal contractor, appointed by Mangaung Metropolitan Municipality in terms of Regulation 5 (1) (k) is required to prepare an occupational health and safety plan. This plan has to be prepared in terms of Regulation 7 (1) as well as Mangaung Metropolitan Municipality occupational health and safety specification. In terms of Regulation 5 (1) (l), Mangaung Metropolitan Municipality and the principal contractor are required to agree on the occupational health and safety plan before any work may commence.

The persons normally most exposed to these penalties as well as reputation risk are the Chief Executive Officer, Chief Financial Officer, Heads of Departments and other members of management all in their personal capacities. The Construction Regulation clearly specifies the duties and responsibilities of the client [Mangaung Metropolitan Municipality in this case] and compliance must be ensured to avoid prosecution.

The implementation and compliance monitoring of the Occupational Health and Safety Act's, No 85 of 1993 (OHSACT) Construction Regulations are specialised in nature and it is therefore recommended that Mangaung Metropolitan Municipality appoint a specialist service provider that will act as its agent [also referred as the Employers appointed Safety Agent] to ensure compliance with the required legislation.

The function of the appointed Safety Agent is to support and assist Mangaung Metropolitan Municipality to implement and maintain a legal compliance Health and Safety management system during the implementation phase of the project. Considering the nature of the project and based on current legal requirements, past experience and best practice, the scope of work to be executed by the appointed Safety Agent will include the following deliverables:

- Undertake a baseline risk assessment for the intended construction work and prepare a comprehensive but project specific occupational health and safety specification for the project based on the outcome of the baseline risk assessment as is required by Construction Regulation 5 (1). This specification will be made available to –
    - The designer so that the designer could take it into consideration during the design stage; and
    - All bidders as part of the tender documentation to use as basis for the development of a project specific occupational health and safety plan
- Assist Mangaung Metropolitan Municipality to evaluate the short-listed bidders' occupational health and safety plans to ensure that they are responsive to Mangaung Metropolitan Municipality occupational health

and safety specification and that the bidders have allowed sufficient budgetary provision for occupational health and safety in their bids as is required by Construction Regulation 5 (1) (g).

- Physical evaluation of the preferred bidder's premises to evaluate the bidder's competence to execute the work tendered for and to ensure that the bidder has the necessary resources to comply with the project's safety requirements (this is a specific requirement of the Construction Regulation 5 (1) (h).
- Undertake a monthly compliance assessment in terms of Construction Regulation 5 (1) (o) on behalf of Mangaung Metropolitan Municipality for the duration of the project so as to ensure that the principal contractor has implemented and maintains the agreed occupational health and safety plan.
- Undertake a final or close-out assessment on behalf of Mangaung Metropolitan Municipality to ensure that the project is duly completed from an OHSACT and its Construction Regulations point of view and to identify all reasonable risks and exposures so as to reduce Mangaung Metropolitan Municipality's public liability and reputation exposures.

15.2. Occupational Health Management and Monitoring Plan

A client who intends to have construction work carried out, must **at least 30 days before** work is to be carried out, apply to the provincial director in writing for a construction work permit should the intended construction work:-

- Exceed 180 days construction period;
- Involve more than 1800 person days;
- Exceed R13m or CIDB level 6.

Once the contract is awarded to the successful bidder [or Contractor in this case] it will be required to perform a detailed risk assessment specific to the type of project that will be implemented. The contractor will then update its "generic" Health and Safety Plan [that was submitted at tender stage] in line with the outcome of its risk assessment and Health and Safety Specification issued by the Employer. The appointed contractor should notify the provincial director at least 7 days before any construction activity commence. The revised Health and Safety Plan will be submitted to the appointed Safety Agent that will evaluate and make recommendation to the plan. Once the final Health and Safety Plan is approved by the Safety Agent, this plan will form the basis of the Health and Safety Management System and Monitoring Plan to be implemented by the contractor.

The contractor will be required to appoint a Health and Safety Officer that will be responsible for the implementation of the contractor's Health and Safety Plan. Various other appointments [for the various types of construction activities] will also be done to assists the contractors Safety Officer in its day to day implementation activities. The contractor will need to appoint First Aiders and Health and Safety Representatives [depending on the amount of employees] in accordance with his Health and Safety Management Plan and the relevant legislation.

The client's appointed Safety Agent will then undertake a monthly compliance assessment in terms of Construction Regulation 5 (1) (o) on behalf of Mangaung Metropolitan Municipality for the duration of the project so as to ensure that the principal contractor has implemented and maintains the agreed occupational health and safety plan.

16. PROCUREMENT REPORT

This section will be expanded in the final TFS report and completion of MMM tariff assessment by Cresco and will include:

16.1. Procurement operating plan
16.2. Fund allocations
16.3. Vendor registrations
16.4. Procurement contracts
16.5. Procurement management and reporting

PART VI – RISK ASSESSMENT AND DUE DILLIGENCE

17. RISK ANALYSIS AND ASSESSMENT REPORT

17.1. Headline Risk Summary and Key Risk Areas

This section will be completed in the final TFS once Cresco and E&Y has completed the funding and structuring sections. Some of the provisional high level risks inlcude:

- Delayed approvals of statutory aspects (WULA, EIA,….)
- DWS opposes GAP scheme
- DWAS may highjack the project and instruct TCTA to implement the project on behalf of Bloem Water/MMM.
- Bloem Water opposes GAP scheme. Bloem Water may try to prevent the project from proceeding in order to support the Caledon scheme.
- Unavailability of allocation from Gariep dam or unwillingness of DWS to approve water use
- Revision of current Bloem Water – MMM water supply agreement
- Insufficient funding to proceed with BFS constructions of project

17.2. Risk matrix and risk rating

A risk matrix with provisional risks rated is attached as Annexure F.

17.3. Risk methodology and assessment

A risk management methodology is attached as Annexure F.

18. DUE DILLIGENCE REPORT

This section will be expanded in the final TFS report and completion of MMM tariff assessment by E&Y and will include the following:

18.1. Technical review
18.2. Project structuring
18.3. Funding and Financial review
18.4. Institutional and legal review
18.5. Value for money review
18.6. Affordability review

PART VII – CONCLUSIONS AND RECOMMENDATIONS

19. CONCLUSIONS AND RECOMMENDATIONS

19.1. Conclusions

Based on historic water demand data and an improved understanding of the water resources available to the region it was concluded that the current MMM water **demand will soon exceed** the available **resources** and water **supply system capacity**. This presents a significant challenge to MMM in terms of its scale, urgency and financial implications. The challenge cannot be addressed as a standalone add-on to existing systems, but needs to be developed as part of an **integrated water resource** system. Integrated water resource planning requires optimisation of relatively low cost local resources after which more costly external resources can be developed.

Mangaung Metropolitan Municipality therefore embarked on a process to develop the Gariep dam Augmentation Project (GAP). A scheme of this scale requires comprehensive enquiry into a wide range of aspects. Not all of these aspects could be addressed in sufficient detail during the time and budget allocated for the technical feasibility study. It was therefore a logical process to split the **feasibility study in two phases**; a technical feasibility study (TFS) and a bankable feasibility study (BFS). The TFS would establish if the project is feasible from a technical point of view, i.e. can it work? It would also highlight additional aspects, risks and activities that will have to be addressed in order to demonstrate if the project is financially viable. Testing the financial, institutional and legal requirements are additional objectives to be tested during the BFS stage. The completion of a BFS will enable MMM to meet the requirements of both the National Treasury PPP requirements and the requirements of private financiers (should grant funding be insufficient). This TFS report has laid the foundation for a subsequent bankable feasibility study (BFS) phase.

A detailed **water balance** was developed for the Bloemfontein area to establish the quantum and phasing of a new external bulk water supply system. A number of operating scenarios were assessed and it was established from the water balance that a Gariep **transfer system** can meet the additional water needs and the **capacity** of such a system could be in the order of **100 - 200 Ml/d** depending on the operating rule and development scenario considered. The operational scenarios selected impacts on the capacity of the Gariep system. The key to choosing the optimal operating scenario lies in two determining factors; the revenue (or savings) that can be generated from the water supply and the operating cost of the water supply system. By operating a lower cost resource such as Maselspoort as a priority plant infrastructure with a higher operating and capital cost, such as the GAP, can be cross-subsidised internally. If operated by an external party such as Bloem Water the **internal cross-subsidization** opportunity is lost.

The local resources available to MMM have not been optimised to date and it was necessary as part of this technical feasibility study to develop a better understanding of the **local water resource opportunities** before the size of a potential external resource such as the GAP, could be established. An essential part of this feasibility study therefore assesses the local resource potential as a point of departure in order to determine the quantum of water required from external sources. Two areas of significant local water resource optimisation have been identified; water conservation and water demand management (WCDM) and indirect potable water

reuse from treated effluent. As a result of its urgency, MMM has already commenced with the implementation of a number of projects to address both local water reuse and WCDM opportunities.

Despite the WCDM and water reuse potential it is estimated that a new bulk water augmentation scheme would be required by 2019 and that the capacity of the scheme needs to be between 100 and 200 Ml/d depending on the operating scenario selected. The planning horizon for such a scheme would be 2035. This transfer scheme would transfer water from the Gariep dam, purifying water close to the Gariep dam and then pump and transfer the potable water directly to Bloemfontein's distribution system.

The technical feasibility study demonstrated that the **Gariep dam Augmentation Project is a feasible project** with many socio-economic benefits to the region. The technical feasibility study also highlighted areas that require further refinement and development in order to ensure that the project is brought to financial close.

The capital cost of the Gariep dam Augmentation Project is currently estimated at R4.3 billion. There is a possibility of implement the project in two phases of which the first phase is estimated to be about R3.6 billion.

The estimated cost to develop the technical feasibility study to a BFS is R 60 million as detailed in Annexure H. Allowances were made for:

- Project management
- Engineering and cost estimation
- Specialist studies and surveys
- Statutory approvals
- Legal fees for contract documentation development
- Project structuring, arranging and financial modelling
- Facilitation of internal processes

It is estimated that the BFS can be substantially completed by the end of 2015 subject to the accelerated statutory approvals. Delivery of the first water to Bloemfontein can be achieved by 2020.

19.2. Recommendations

Based on the outcome of the TFS it is recommended that the Gariep dam Augmentation Project (GAP) be developed to meet the future demands of Bloemfontein and the greater MMM. There are, however, still a number of key project gaps that needs to addressed during the BFS. It is recommended that MMM budget and provide funding for the completion of the TFS during the F2015/16 budget.

The technical feasibility study (TFS) had to be completed in a relatively short time, which was inadequate to address a number of technical, financial, legal and institutional aspects. A range of activities have to be initiated during the bankable feasibility stage. The key activities are summarised below. It should also be noted that some of these activities are on the critical path and will have to be commissioned shortly after the decision to proceed with the BFS was made.

19.2.1. Technical recommendations

In respect of the Technical aspects the following is recommended:

- MMM to appoint a project manager to oversee the GAP preparation and implementation.
- MMM should complete detail design aspects of all the GAP components.
- MMM should commission detailed specialist investigations for topographical, geotechnical, cathodic protection, radio path, land use, environmental impact and power supply availability in order to complete the detail design and meet conditions precedent of financial close.
- MMM to commence with identification of land use requirements and acquisition of land along pipeline corridor.
- MMM should develop procurement specifications.
- MMM to develop project procurement mechanisms and procurement documentation once the project structure has been determined.
- MMM to prepare detailed cost estimates once the detail designs have been completed.

In parallel to the Technical aspects required for the GAP the following recommendations are made towards the development of local water resources and supply systems:

- MMM should recognise the importance and financial benefit of utilising local water resources and the impact on the feasibility of the GAP.
- MMM has access to readily available and exploitable surface water resources, i.e. treated effluent discharged into the Rhenosterpruit. These resources should be transferred into Mockes dam to fulfil the dual role of storage and an engineered buffer.
- MMM should develop a water reuse facility to utilise the treated effluent discharged into Mockes dam. The expansion and process upgrades currently planned for Maselspoort WTW should be completed by MMM to enable indirect potable water reuse.
- The local potable reuse should be pursued as a matter of urgency to reduce nett imports from external sources.
- MMM should continue to implement and finance water conservation and water demand management. The WCDM program should focus on real losses reduction and increase of authorised metered consumption in order to reduce unit water cost and maximise income.

19.2.2. Structuring recommendations

In respect of the project Structuring aspects the following is recommended:

- MMM to develop and choose the most appropriate project preparation and implementation structure and mechanism
- ….
- …This section will be completed once the Cresco report is available

19.2.3. Financial recommendations

In respect of the project Financial aspects, the following is recommended:

- MMM to refine the project CAPEX estimate once the detail design has been completed
- MMM to refine the project OPEX estimate once the detail design has been completed and integrate the OPEX with the most suitable use of local resources
- MMM to choose the most cost effective operational scenario and develop revised operational rules to determine which combination of sources provides the lowest operating cost.
- MMM to develop and refine project financial model for project preparation stage, project implementation stage and O&M stage.
- MMM to develop and refine detailed revenue model and detailed tariff model to establish affordability of GAP, the impact on future MMM water tariffs and impact on Bloem Water.
-
- This section will be completed once the E&Y and Cresco reports are available

19.2.4. Funding recommendations

In respect of the project Funding aspects, the following is recommended:

- MMM to identify potential funding sources by assessing available government grants, international grants and commercial finance
- MMM to determine funding conditions, eg. interest rates, funding term.
- MMM to complete project preparation process (BFS) to a point where PPP requirements of National Treasury could be met for grant funding and underwriting by Treasury
- MMM also approves the use of limited recourse project finance as additional finance that may be required to fund the project should grants from National Treasury be insufficient for total project CAPEX;
- MMM to negotiate, apply for, source and confirm multiple project underwriters from National Treasury and commercial financiers.
- MMM to develop a funding model and update project financial model.
- MMM to update revenue, cost recovery and tariff model once funding sources have been determined.
- MMM to establish affordability
- MMM to establish bankability
- MMM to establish project financial close after demonstrating affordability and meeting all BFS conditions precedent.
- This section will be completed once the Cresco report is submitted.

19.2.5. Legal recommendations

In respect of the Legal aspects, the following is recommended:

- MMM to develop a suite of procurement documents for various aspects of project preparation and implementation; procurement of funding, procurement of contractors, procurement of operators.
- MMM to develop range of agreements to govern PPP model if it is decided this to be the most suitable

project implementation model; off-take agreements, supply agreements, funding agreement, loan agreement, O&M agreement, construction agreement etc.

- MMM to commence immediately with the renegotiation of a new MMM- Bloem Water supply agreement for two reasons; firstly to remove the need to pay for raw water at Maselspoort except in cases where transfers are required from the Caledon river via the Novo scheme, secondly to reduce the uptake from the Bloem Water scheme as and when required once the local water optimisations have been completed and once the GAP has been constructed.
- Section to be updated…….

19.2.6. Statutory approval recommendations

In respect of Statutory approvals, the following is recommended:

- MMM needs to commission a range of statutory approvals as part of the BFS.
- MMM to commission application for raw water from Gariep dam in terms of section 21(a) of NWA.
- MMM to develop and submit an integrated WULA addressing all section 21 water uses, including current water uses.
- MMM to obtain permission from DWS to modify abstraction point in Gariep dam for GAP.
- MMM to apply for power and source firm quote from ESKOM for all power requirements.
- MMM to apply for status as Independent Power Producer for planned Solar Power Supply System.
- MMM to commission EIA and all specialist studies in order to obtain environmental authorisation. The EIA will also include a Socio-Economic impact assessment as well as Heritage impact assessment.
- MMM to apply for mining rights for borrow pits and obtain mining licenses for the same.
- MMM to obtain approvals from COGTA, DWS and National Treasury for potential grant funding from (RBIG, MIG, USDG….)

19.2.7. Internal process recommendations

In respect of Internal processes, the following is recommended:

- MMM to approve technical feasibility study recommendations to continue with project preparation to BFS stage.
- MMM to approve proposed BFS scope and budget of R60 million to proceed with BFS. Refer to Annexure H for a detailed cost breakdown.
- MMM to follow up in writing commitments made by DWS regarding prioritisation of water reuse and delaying of infrastructure upgrades commissioned by Bloem Water.
- MMM to approve BFS project structure; project leader, project secretariat and project advisor in terms of PPP regulations.
- MMM to continue development and implementation of other local water optimisation projects, i.e. WCDM and water reuse and ensure that these project implementation schedule are aligned with GAP schedule.
- MMM to update IDP, WSDP, Water and Sanitation Master Plan and other MMM planning documents to indicate GAP and local water resource optimisation.
- MMM to obtain approval for incurring cost for GAP in terms of annual budget (adjustment budget)

approval process.

- MMM to initiate and complete the section 78 process in terms of the Municipal Systems Act in respect of the operation and maintenance of its bulk water systems.
- MMM to appoint a service provider to update the previous section 78 (of the Municipal Systems Act) process to include the provision of bulk water services as an external mechanism;
- MMM to issue the required notices in terms of section 78 of the Municipal Systems Act that it intends to implement an External Mechanism as outlined in this report;
- MMM to approve process to commence with section 197 of LBA for any employees that may be affected by the section 78 outcomes.
- MMM to confirm cost recovery rates and affordability of proposed Gariep scheme

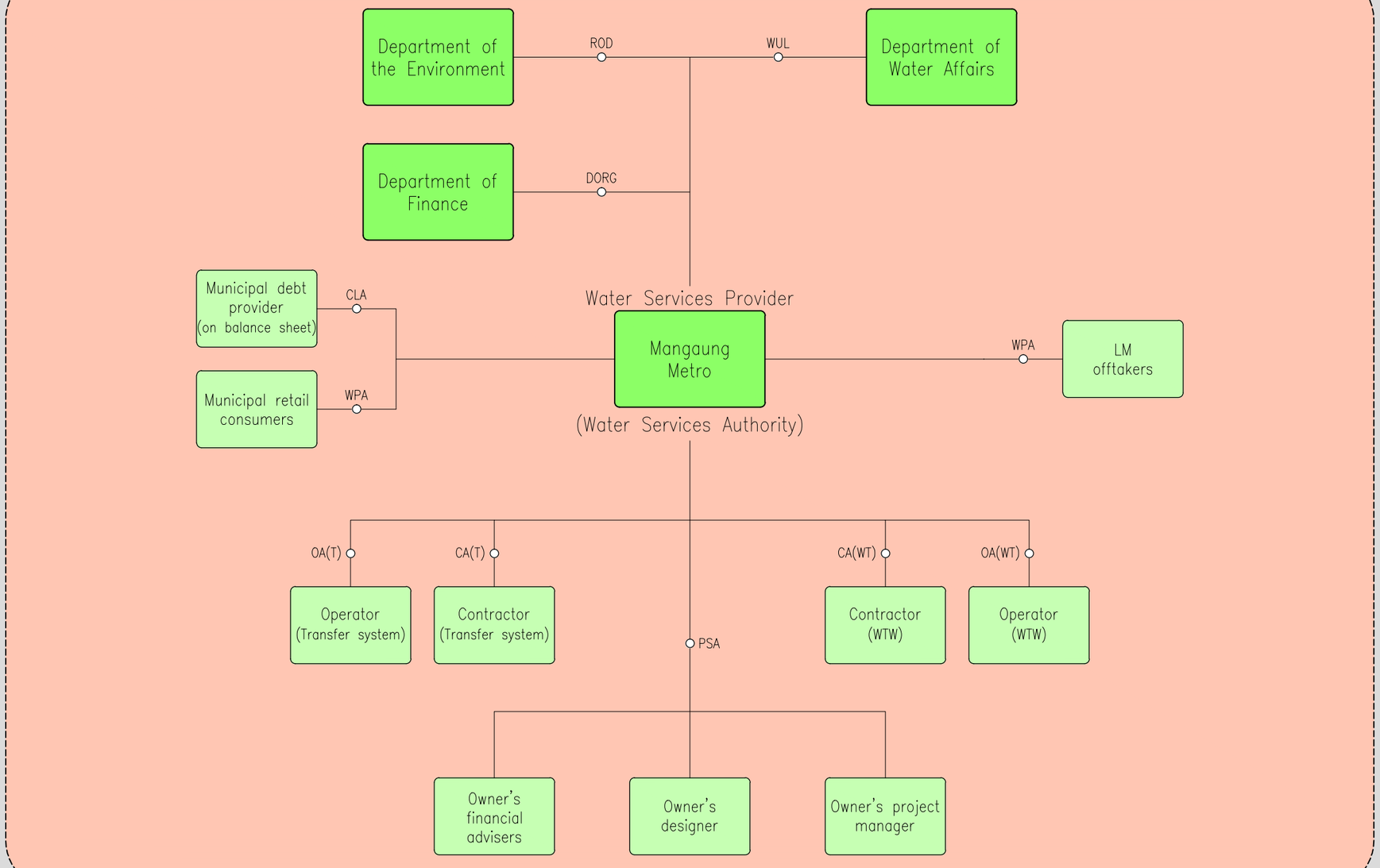
The statutory activities that need to be addressed are summarised in Table 19.1.

Area of activity	Activity
Technical	• Appoint a project manager • Complete detail design of GAP components. • Commission detailed specialist investigations; topographical, geotechnical, cathodic protection, radio path, land use, environmental impact and power supply availability. • Commence with land use requirements and acquisition along pipeline corridor. • Develop procurement specifications for infrastructure. • Develop project procurement mechanisms and documentation. • Prepare detailed cost estimates for infrastructure.
Structuring	• Determine most appropriate project implementation structure and mechanism
Financial	• Refine project CAPEX estimate • Refine project OPEX estimate • Choose most cost effective operational scenario • Refine project financial model for project preparation and implementation • Refine revenue and tariff model to establish affordability
Funding	• Identify potential funding sources • Establish funding conditions • Confirm project underwriting from National Treasury and private financiers to meet PPP requirements • Approve use of limited recourse commercial funding sources • Confirm multiple project underwriters • Develop funding model and update project financial model • Update revenue, cost recovery and tariff model • Establish affordability • Establish bankability • Establish project close
Legal	• Develop suite of procurement documents • Develop suite of PPP agrrements • Amend MMM- Bloem Water supply agreement
Statutory approvals	• Apply for Section 21(a) (NWA) application for abstraction • Preparation and submission of WULA • Preparation of details for Gariep dam abstraction modification • Application for ESKOM power supply and application as IPP for solar farm

	• Submit environmental assessments; • Mining (Application for mining rights for borrow pits) • Approval of grant funding from National Treasury, COGTA and DWS
Internal processes	• Approve technical feasibility study recommendations to continue with project preparation to BFS stage. • Approve process and budget to proceed with BFS. • Follow up on MMM letter to DWS regarding Bloem Water and Gariep pipeline • Approve BFS project structure; project officer, project secretariat and project advisor • Continue development and implementation of WCDM and water reuse local resources as first priority • Update IDP, WSDP and other MMM planning documents to indicate GAP • Approve process to commence with section 78 (MSA) process and approve service provider • Approve process to commence with section 197 (LBA) process • Update and approve annual MMM budget • Confirm cost recovery and affordability of GAP

Table 19.1 – List of key recommended MMM activities before and during BFS stage
(to be completed once E+Y and Cresco reports are completed).

Annexure A – Drawings and Maps



LEGEND

WUL	Water use license
ROD	Record of decision
WPA	Water purchase agreements
PSA	Professional services agreement
DORG	Division of revenue grant
CA(T)	Construction agreement (transfer)
CA(WT)	Construction agreement (water treatment)
OA(T)	Operating agreement (transfer)
OA(WT)	Operating agreement (water treatment)

AS-BUILT RECORD

CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

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No.	DATE	DESCRIPTION	AUTHORISED BY

BIGEN AFRICA Services (PTY) LTD
Allan Cormack Street
The Innovation Hub Persequor Pretoria
PO Box 29 The Innovation Hub Pretoria 0087
Tel:+ 27 (0) 12 842 8700
Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:
CONTRACTUAL ARRANGEMENT INTERNAL MECHANISM

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
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ORIGINAL DRAWING SCALE:		ORIGINAL DRAWING SHEET SIZE:	A1

APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
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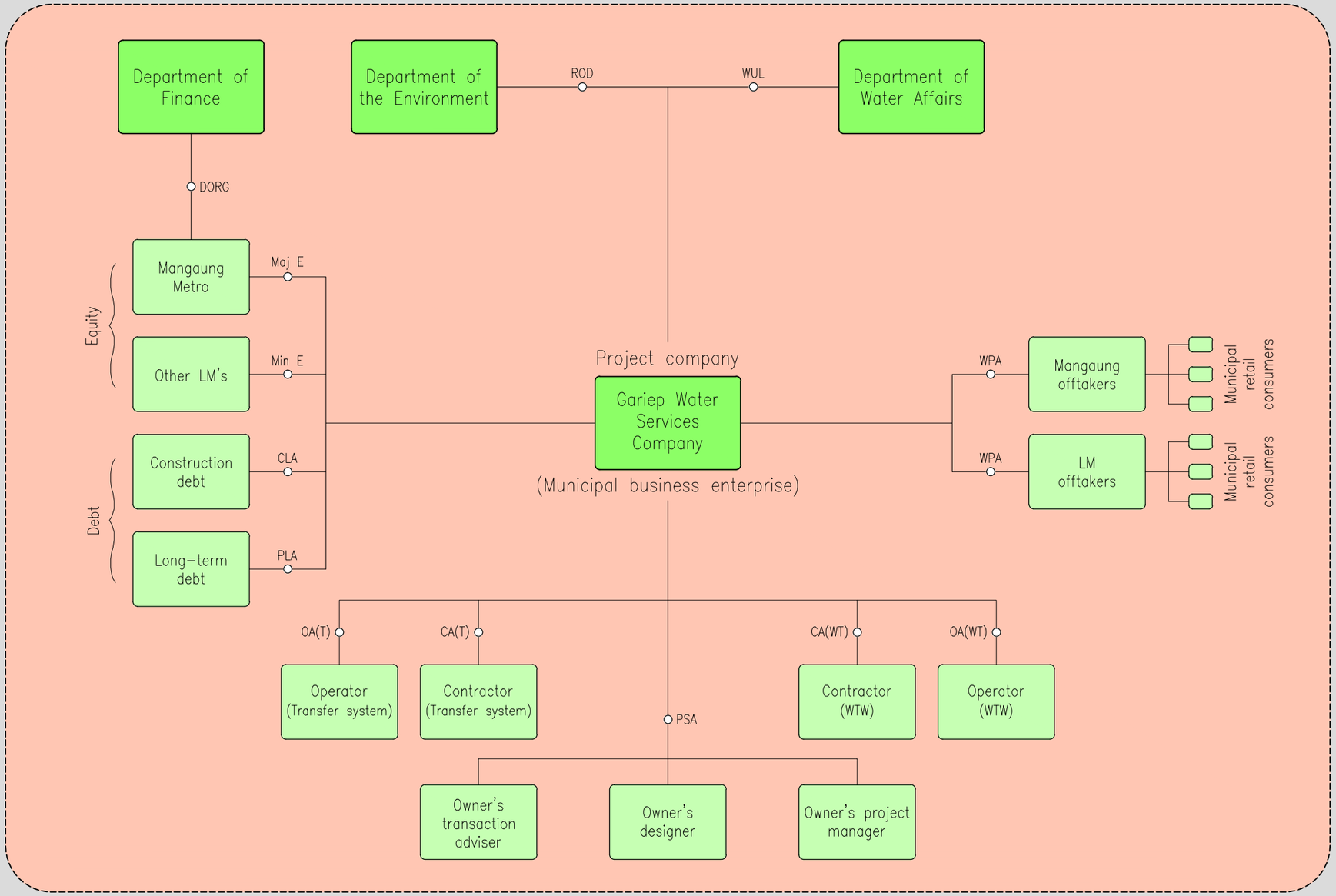
SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	May 2015

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____
DRAWING No.: 2485.00.AAA.01.A010 | VERSION: A.0

2485.00.AAA.01.A010



LEGEND

WUL	Water use license	PSA	Professional services agreement
Maj E	Majority equity (ownership & control)	DORG	Division of revenue grant
Min E	Minority equity (ownership & control)	CA(T)	Construction agreement (transfer)
ROD	Record of decision	CA(WT)	Construction agreement (water treatment)
CLA	Construction loan agreement	OA(T)	Operating agreement (transfer)
PLA	Project loan agreement	OA(WT)	Operating agreement (water treatment)
WPA	Water purchase agreements		

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PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:
CONTRACTUAL ARRANGEMENT EXTERNAL MECHANISM

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
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CO-ORDINATE SYSTEM:		DATE:	May 2015
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CLIENT REF No.:

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____
DRAWING No.: 2485.00.AAA.01.A011
VERSION: A.0

2485.00.AAA.01.A011

Mangaung Metro Municipality (MMM) Bulk Water Supply & Sanitation Programme

Internal Sanitation System 1. Upgrades (Bloemspruit)

- 1.1. **Infrastructure**
  - 1.1.1. Inlet Works Upgrade
  - 1.1.2. Primary Settling Tank (PST) Upgrade
  - 1.1.3. Biofilter Upgrade
  - 1.1.4. Secondary Settling Tank (SST) Upgrade
  - 1.1.5. Digester Upgrade
  - 1.1.6. Improved Biological Nutrient Removal Upgrade
  - 1.1.7. Tertiary Treatment Upgrade
- 1.2. **Services**
- 1.3. **Investigations**
  - 1.3.1. Abstraction
  - 1.3.2. Topographical
  - 1.3.3. Geotechnical
  - 1.3.4. Environmental impact
  - 1.3.5. Water use
  - 1.3.6. Land use/servitudes
  - 1.3.7. Economic impact
  - 1.3.8. Power supply
- 1.4. **Project Management**

Internal Transfer 2. System Upgrades

- 2.1. **Infrastructure**
  - 2.1.1. Bloemspruit Transfer Pipeline
    - 2.1.1.1. North Eastern to Mockes Dame Pipeline
    - 2.1.1.2. Bloemspruit to Mockes Dam Pipeline
  - 2.1.2. North Eastern Transfer Pipeline
- 2.2. **Services**
  - 2.2.1. Bloemspruit Transfer Pipeline
    - 2.2.1.1. Early Warning System
  - 2.2.2. North Eastern Transfer Pipeline
- 2.3. **Investigations**
  - 2.3.1. Dam abstraction
  - 2.3.2. Topographical
  - 2.3.3. Geotechnical
  - 2.3.4. Environmental impact
  - 2.3.5. Water use
  - 2.3.6. Land use/servitudes
  - 2.3.7. Economic impact
  - 2.3.8. Power supply
- 2.4. **Project Management**

Internal Storage 3. Systems Upgrades

- 3.1. **Infrastructure**
  - 3.1.1. Mockes Dam Wall increase
  - 3.1.2. Mockes Dam safety repairs
- 3.2. **Services**
- 3.3. **Investigations**
  - 3.3.1. Dam abstraction
  - 3.3.2. Topographical
  - 3.3.3. Geotechnical
  - 3.3.4. Environmental impact
  - 3.3.5. Water use
  - 3.3.6. Land use/servitudes
  - 3.3.7. Economic impact
  - 3.3.8. Power supply
- 3.4. **Project Management**

Internal Potable Water 4. Treatment System Upgrades

- 4.1. **Infrastructure**
  - 4.1.1. Refurbishment & De-bottleneck
  - 4.1.2. Dissolved Air Floatation (DAF) Upgrade
  - 4.1.3. Advanced Treatment ozone
  - 4.1.4. Advanced Treatment GAC
  - 4.1.5. Sludge management system
  - 4.1.6. Supernatant recovery system
  - 4.1.7. Wash water recovery system
- 4.2. **Services**
  - 4.2.1. Refurbishment & De-bottleneck
    - 4.2.1.1. Control, Communications & SCADA
    - 4.2.1.2. Exposing of Services and Surveying
  - 4.2.2. DAF Upgrade
    - 4.2.2.1. MCC Upgrades
  - 4.2.3. Advanced Treatment Ozone
    - 4.2.3.1. MCC and LV Distribution Upgrade
  - 4.2.4. Advanced Treatment GAC
    - 4.2.4.1. MCC and LV Distribution Upgrade
- 4.3. **Investigations**
  - 4.3.1. Dam abstraction
  - 4.3.2. Topographical
  - 4.3.3. Geotechnical
  - 4.3.4. Environmental impact
  - 4.3.5. Water use
  - 4.3.6. Land use/servitudes
  - 4.3.7. Economic impact
  - 4.3.8. Power supply
- 4.4. **Project Management**

External Gariep Bulk 5. Water System Project

- 5.1. **Infrastructure**
  - 5.1.1. Abstraction Works
  - 5.1.2. Low Lift Pumping Station
  - 5.1.3. Raw Water Main
  - 5.1.4. Water Treatment Works
  - 5.1.5. High Lift Pumping Station 1
  - 5.1.6. Delivery Main 1
  - 5.1.7. High Level Storage
  - 5.1.8. Gravity Main 1
  - 5.1.9. Gravity Main 2
  - 5.1.10. Booster Pumping Station
  - 5.1.11. Small Town Draw-off's
  - 5.1.12. Terminal Reservoir
  - 5.1.13. Down Stream Integration
  - 5.1.14. Cathodic Protection
- 5.2. **Services**
  - 5.2.1. Regional Control and Communication
  - 5.2.2. Bulk Power Supply
  - 5.2.3. Security
- 5.3. **Investigations**
  - 5.3.1. Dam abstraction
  - 5.3.2. Topographical
  - 5.3.3. Geotechnical
  - 5.3.4. Environmental impact
  - 5.3.5. Water use
  - 5.3.6. Land use/servitudes
  - 5.3.7. Radio path
  - 5.3.8. Economic impact
  - 5.3.9. Power supply
- 5.4. **Project Management**
  - 5.4.1. Feasibility
  - 5.4.2. Implementation
  - 5.4.3. Close-out

6. Programme Management

- 6.1. **Feasibility**
  - 6.1.1. Initiation
  - 6.1.2. Planning
  - 6.1.3. Execution
    - 6.1.3.1. Water & Sanitation Master Plan
    - 6.1.3.2. Programme Study Report
      - 6.1.3.2.1 Scoping
      - 6.1.3.2.2 Engineering
      - 6.1.3.2.3 Schedule development
      - 6.1.3.2.4 Estimation
      - 6.1.3.2.5 Risk Management
      - 6.1.3.2.6 Operational Readiness
    - 6.1.3.3. Programme Execution Plan
  - 6.1.4. Closing
  - 6.1.5. Assurance
- 6.2. **Implementation**
- 6.3. **Close-out**
- 6.4. **Operate and Maintain**

AS-BUILT RECORD

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VERSION/AMENDMENTS

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E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:
MANGAUNG METRO MUNICIPALITY BULK WATER SUPPLY AND SANITATION PROGRAMME

MANGAUNG METRO MUNICIPALITY METRO MUNISIPALITEIT LEKGOTLA LA MOTSE

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DRAWN	A Steenberg	CHECKED	D Sutton
ORIGINAL DRAWING SCALE:	NTS	ORIGINAL DRAWING SHEET SIZE:	A1
CO-ORDINATE SYSTEM:		DATE:	May 2015

APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
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APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____
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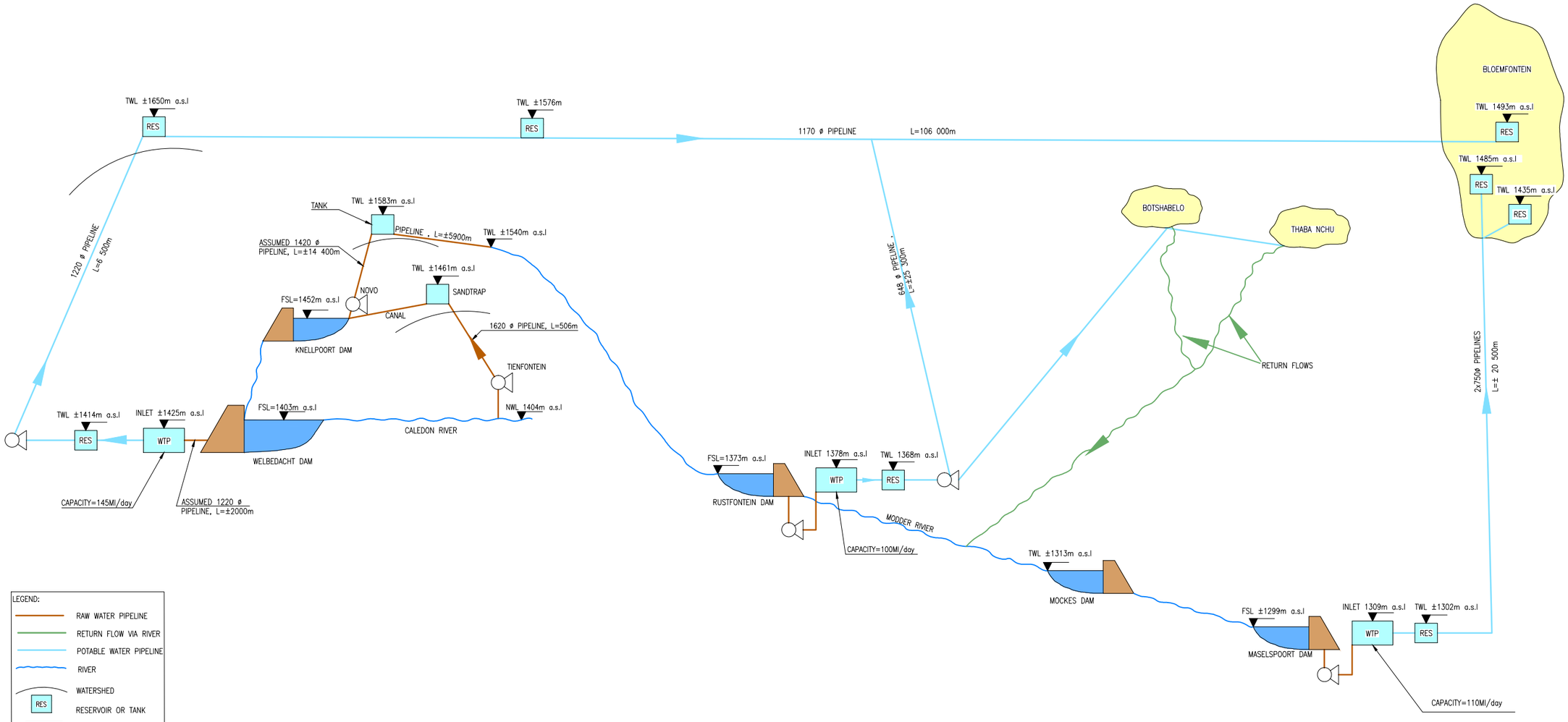
2485.00.AAA.01.A012



LEGEND:

- RAW WATER PIPELINE
- RETURN FLOW VIA RIVER
- POTABLE WATER PIPELINE
- RIVER
- WATERSHED
- RES — RESERVOIR OR TANK
- WTP — WATER TREATMENT PLANT
- PUMPSTATION
- DAM
- FSL — FULL SUPPLY LEVEL
- TWL — TOP WATER LEVEL
- NWL — NORMAL WATER LEVEL
- m — METERS
- a.s.l — ABOVE SEA LEVEL

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www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:
SCHEMATIC LAYOUT OF BULK WATER SUPPLY SYSTEMS TO THE GREATER BLOEMFONTEIN AREA

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

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ORIGINAL DRAWING SCALE:	NTS	ORIGINAL DRAWING SHEET SIZE:	A1

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SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	May 2015

APPROVED ON BEHALF OF BIGEN AFRICA:
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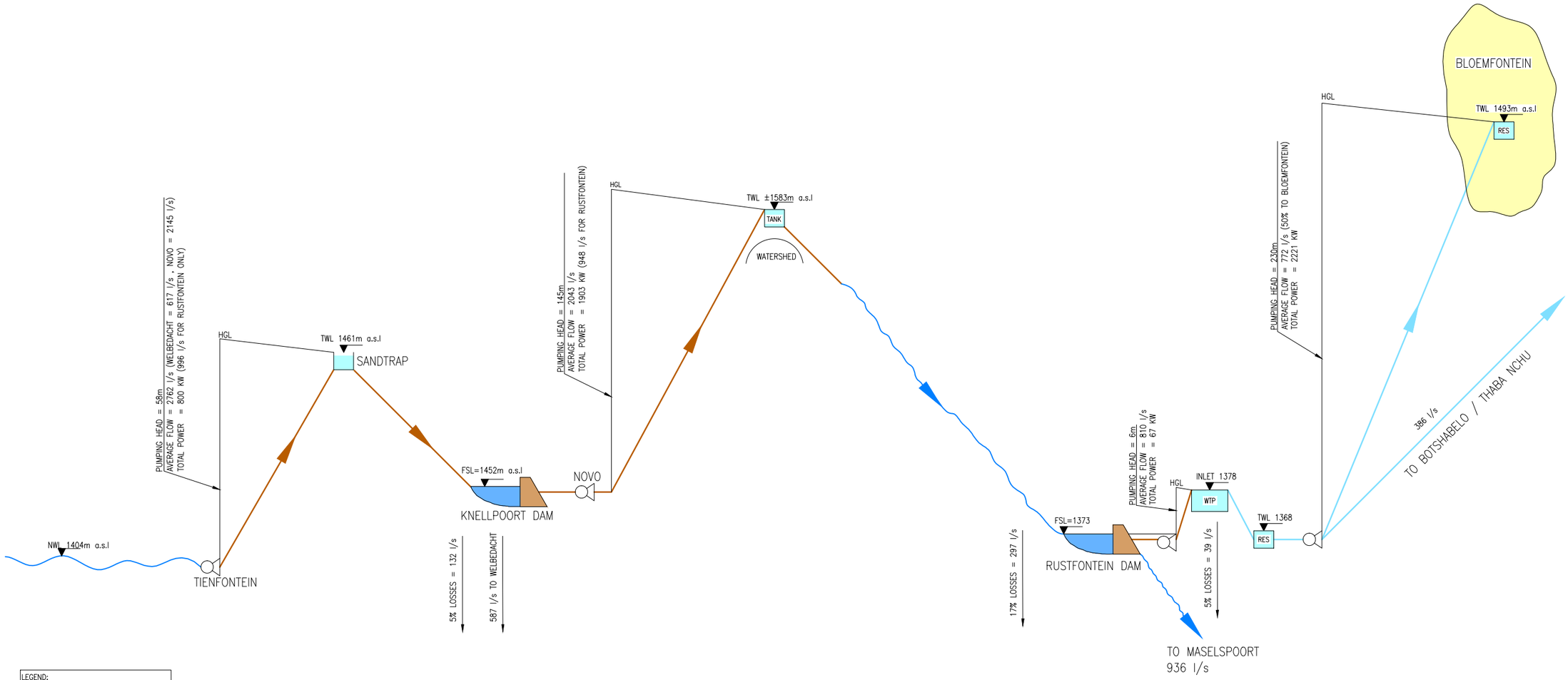
2485.00.AAA.01.A015



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- NWL — NORMAL WATER LEVEL
- m — METERS
- a.s.l — ABOVE SEA LEVEL

TOTAL PUMPING HEAD = 439m
POTABLE WATER FLOW = 772 l/s (AVERAGE) 50% TO BLOEMFONTEIN
ESTIMATED TOTAL RAW WATER LOSSES ATTRIBUTED TO RUSTFONTEIN = 224 l/s (29%)
TOTAL POWER = 4991 KW
ENERGY REQUIRED PER kl POTABLE WATER SUPPLIED = 6465 KW

AS-BUILT RECORD

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E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:
SCHEMATIC LONG SECTION THROUGH RUSTFONTEIN WATER SUPPLY SYSTEM

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

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DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	May 2015

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

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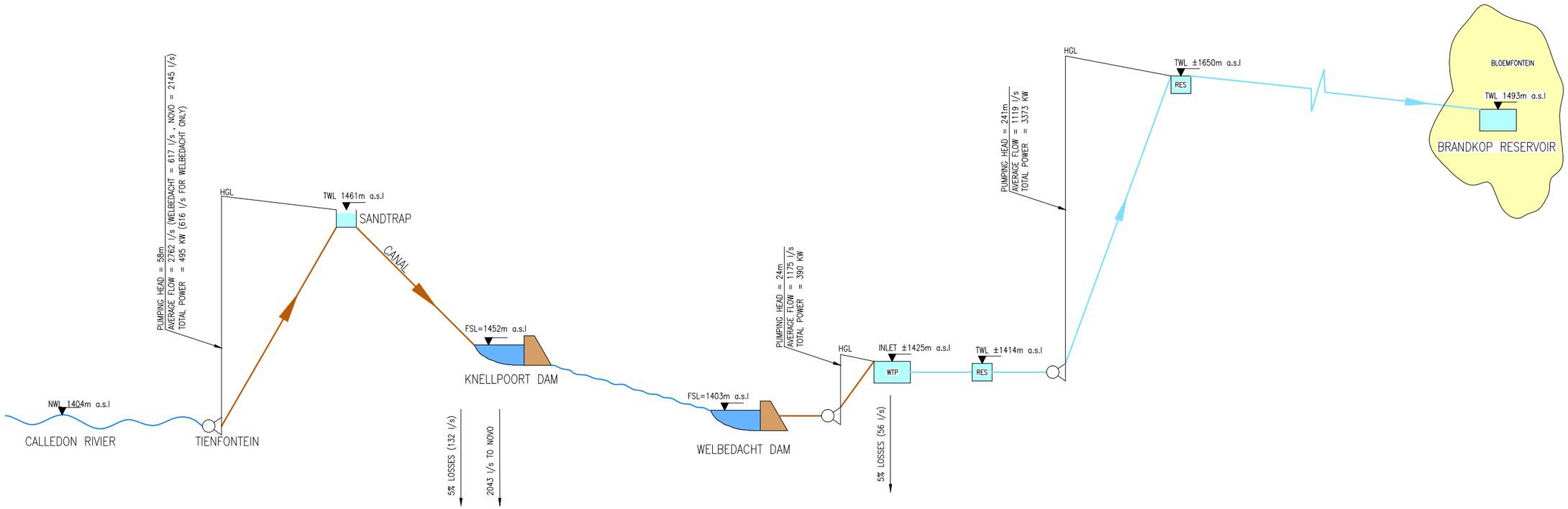

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TOTAL PUMPING HEAD = 323m
POTABLE WATER FLOW = 1119 l/s (AVERAGE)
ESTIMATED TOTAL RAW WATER LOSSES = 112 l/s (10%) (PRO RATA PORTION OF KNELLPOORT LOSSES INCLUDED)
TOTAL POWER = 4258 KW
ENERGY REQUIRED PER kl POTABLE WATER SUPPLIED = 3805 KW

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PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
SCHEMATIC LONG SECTION THROUGH WELBEDACHT WATER SUPPLY SYSTEM

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
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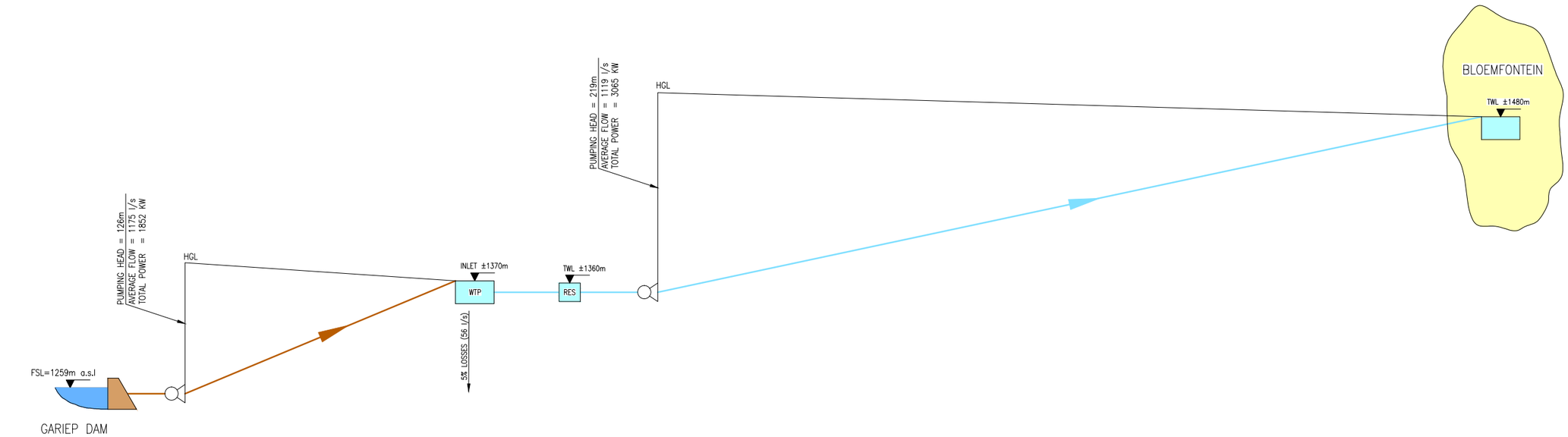

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TOTAL PUMPING HEAD = 345m
POTABLE WATER FLOW = 1119 l/s (AVERAGE)
ESTIMATED TOTAL RAW WATER LOSSES = 56 l/s (5%)
(PRORATA PORTION OF KNELLPOORT LOSSES INCLUDED)
TOTAL POWER = 4917 KW
ENERGY REQUIRED PER kl POTABLE WATER SUPPLIED = 4394 KW

AS-BUILT RECORD

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www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
SCHEMATIC LONG SECTION THROUGH PROPOSED GARIEP WATER SUPPLY SYSTEM

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

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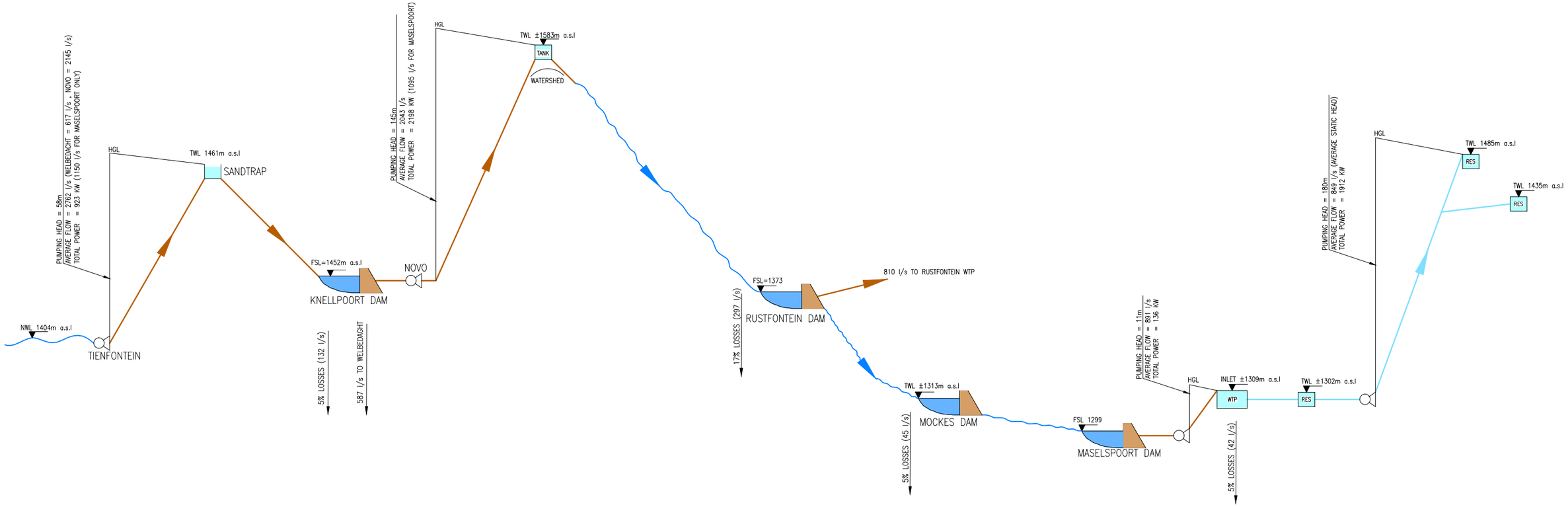

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TOTAL PUMPING HEAD = 394m
POTABLE WATER FLOW = 0,849 l/s (AVERAGE)
ESTIMATED TOTAL RAW WATER LOSSES = 300 l/s (35%)
TOTAL POWER = 5169 KW
ENERGY REQUIRED PER kl POTABLE WATER SUPPLIED = 6088 KW

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PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
SCHEMATIC LONG SECTION
THROUGH MASELSPOORT
WATER SUPPLY SYSTEM

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
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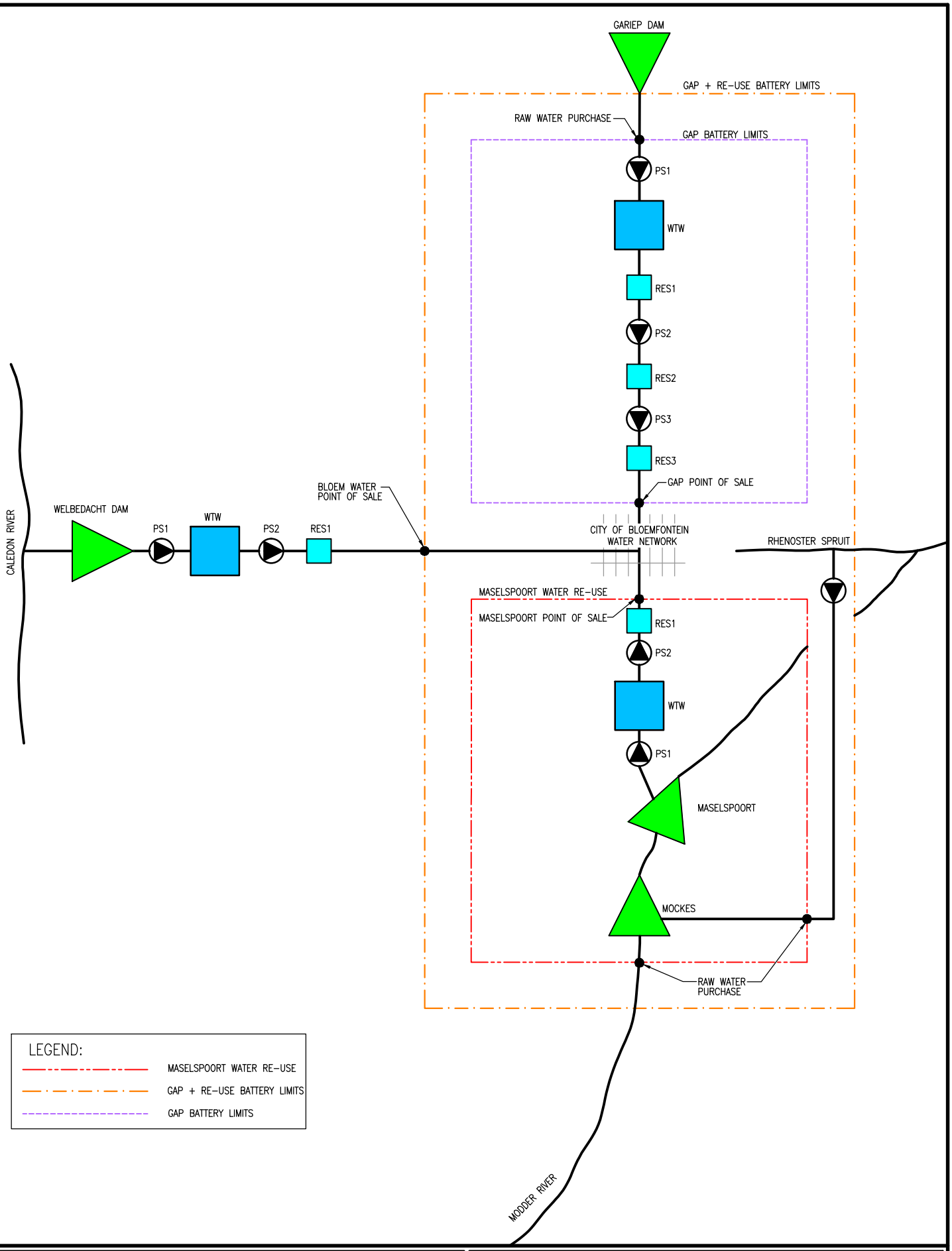

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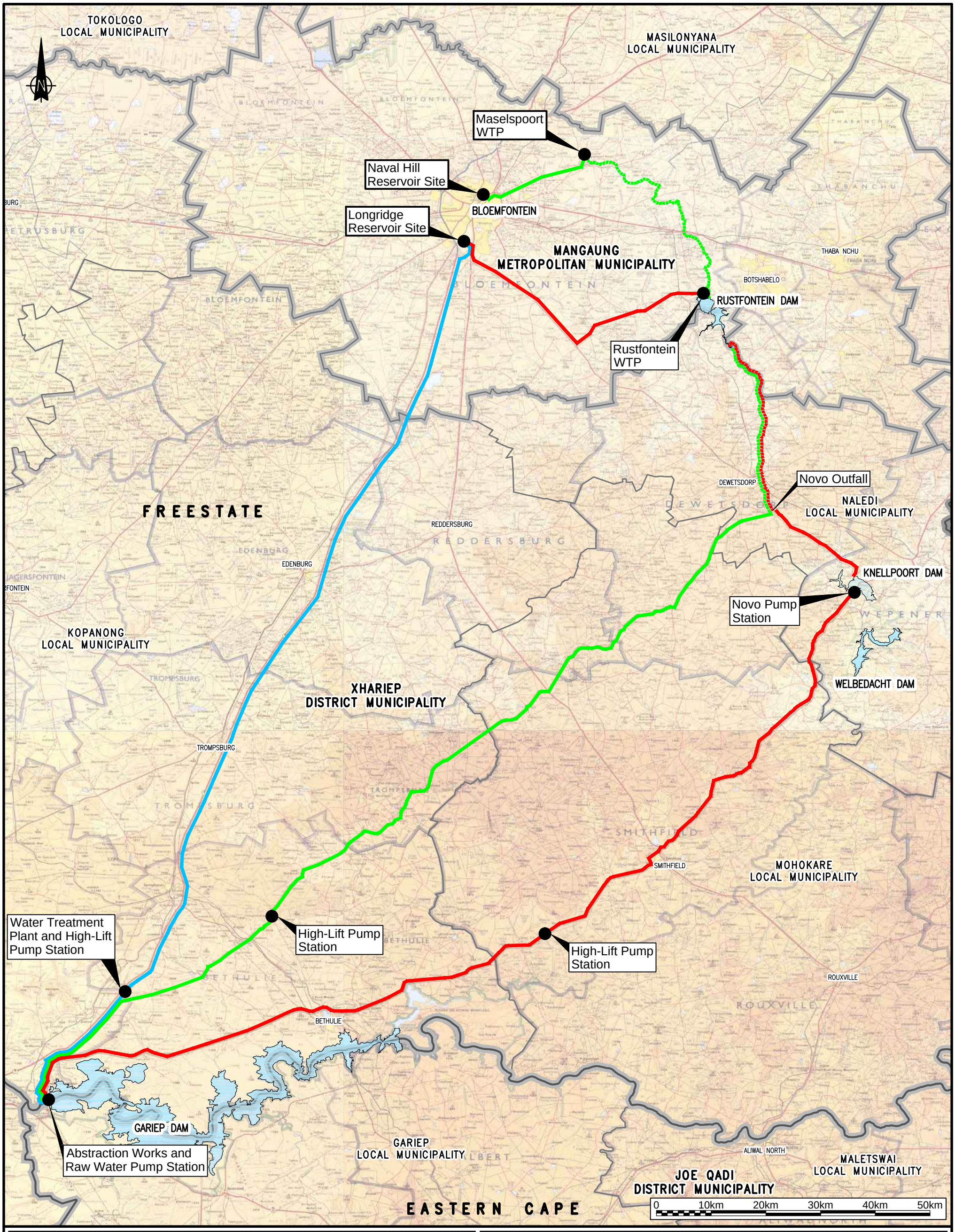
www.bigenafrica.com

PROJECT: GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DWG TITLE: SCHEMATIC DIAGRAM OF FUTURE WATER SUPPLY SYSTEMS FOR BLOEMFONTEIN

DRAWN:	CHECKED:	APPROVED:	SCALE:	DATE:	DWG No:	VER:
R.Snyman	M.vd.Walt	M.vd.Walt	N.T.S	06/2015	2485.00.AAA.01.A020	1.0



Engineering Services | Management Consulting Services | Project Finance Services | Infrastructure Development Services

BIGEN AFRICA Services (PTY) LTD
Allan Cormack Street
The Innovation Hub Persequor Pretoria
PO Box 29 The Innovation Hub Pretoria 0087
Tel:+ 27 (0) 12 842 8700
Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

Engineering solutions

BIGEN AFRICA

PROJECT: GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DWG TITLE: GARIEP DAM TO BLOEMFONTEIN TRANSFER OPTIONS

DRAWN:	CHECKED:	APPROVED:	SCALE:	DATE:	DWG No:	VER:
A STEENBERG	M vd WALT	M vd WALT	AS SHOWN	MAY 2015	2485.00.AAA.01.S001	A.0

AS-BUILT RECORD			
CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER DATE

VERSION/AMENDMENTS			
No.	DATE	DESCRIPTION	AUTHORISED BY

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E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
LOCALITY
RAW WATER PUMP STATION

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	NTS	ORIGINAL DRAWING SHEET SIZE:	A1

APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.: CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	May 2015

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.:	VERSION:
2485.00.AAA.10.A001	A.0

2485.00.AAA.10.A001

AS-BUILT RECORD			
CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

_____ _____

ENGINEER DATE

VERSION/AMENDMENTS			
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E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:

GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:

LOCALITY
WATER TREATMENT PLANT AND HIGH LIFT PUMP STATION

MANGAUNG
METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	NTS	ORIGINAL DRAWING SHEET SIZE:	A1

APPROVED:

CLIENT OR ASSIGNEE: _____ DATE: _____

CLIENT DRAWING No.:	CLIENT REF No.:

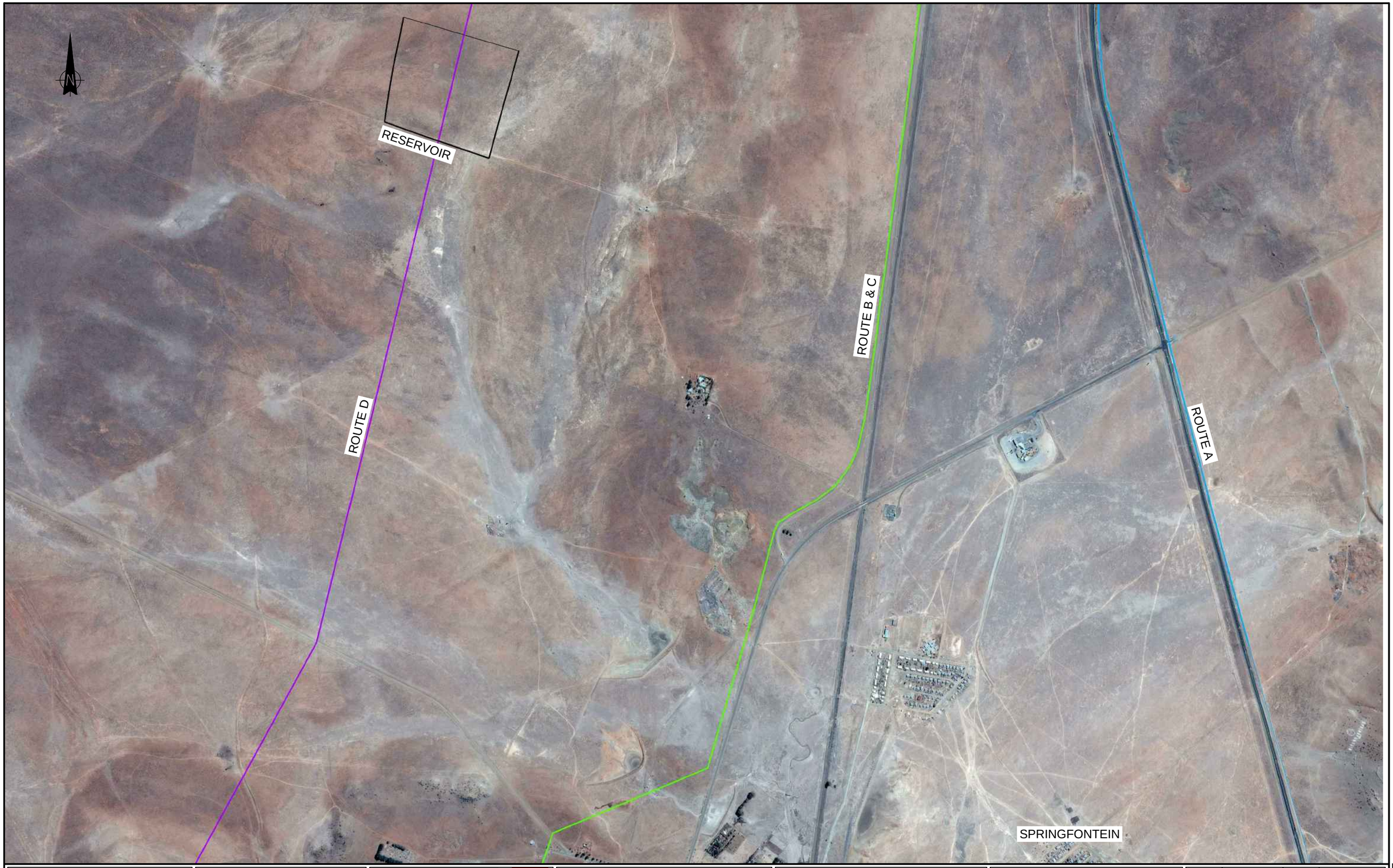
SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	May 2015

APPROVED ON BEHALF OF BIGEN AFRICA:

ENGINEER: _____ DATE: _____

DRAWING No.:	VERSION:
2485.00.AAA.10.A002	A.0

2485.00.AAA.10.A002



AS-BUILT RECORD			
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E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
LOCALITY
STORAGE RESERVOIR

MANGAUNG
METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	NTS	ORIGINAL DRAWING SHEET SIZE:	A1

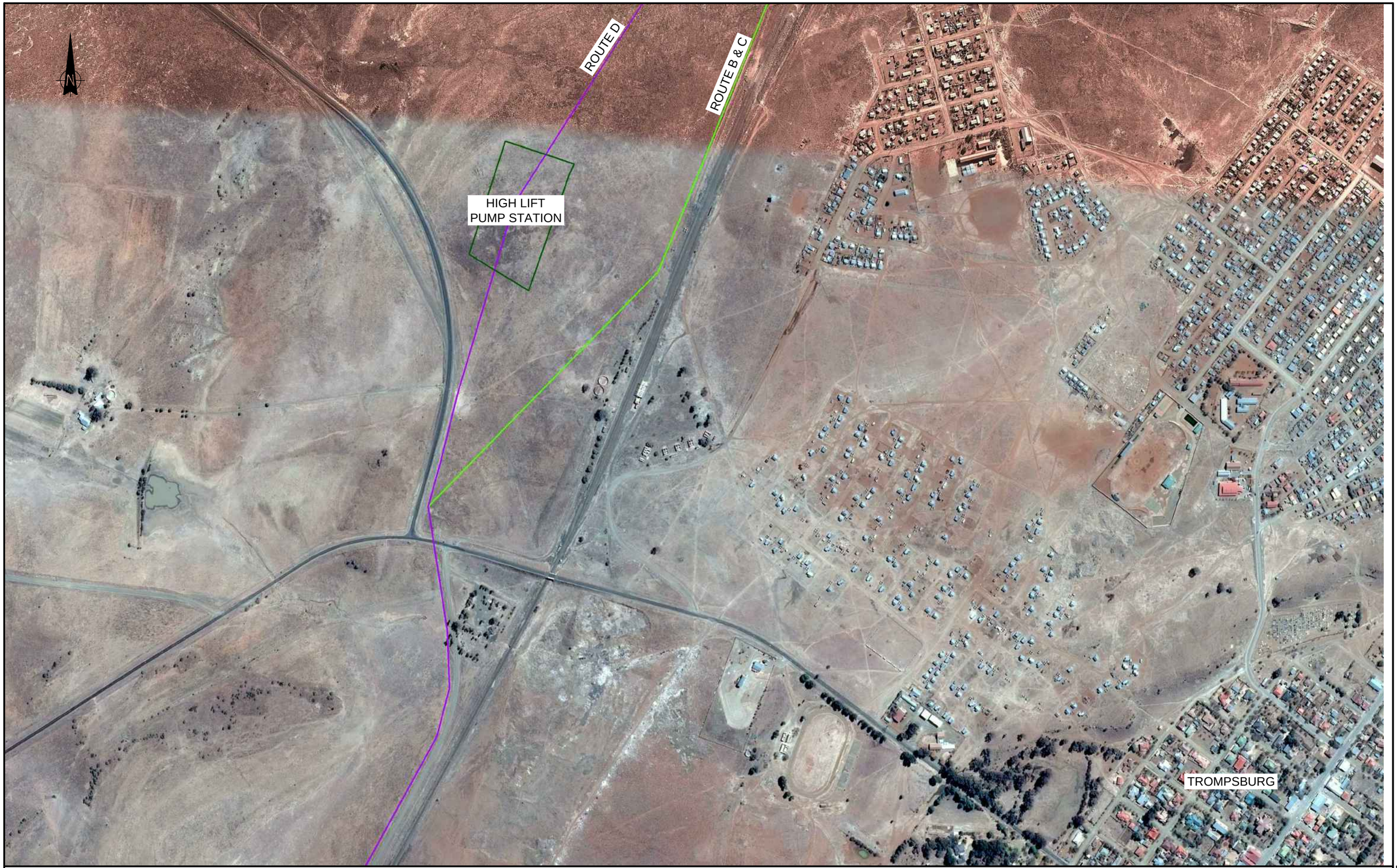
APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.: CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	May 2015

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.: 2485.00.AAA.10.A003
VERSION: A.0

2485.00.AAA.10.A003



AS-BUILT RECORD			
CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER DATE

VERSION/AMENDMENTS			
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www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
LOCALITY
HIGH LIFT PUMP STATION

MANGAUNG
METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	NTS	ORIGINAL DRAWING SHEET SIZE:	A1

APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.: | CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	May 2015

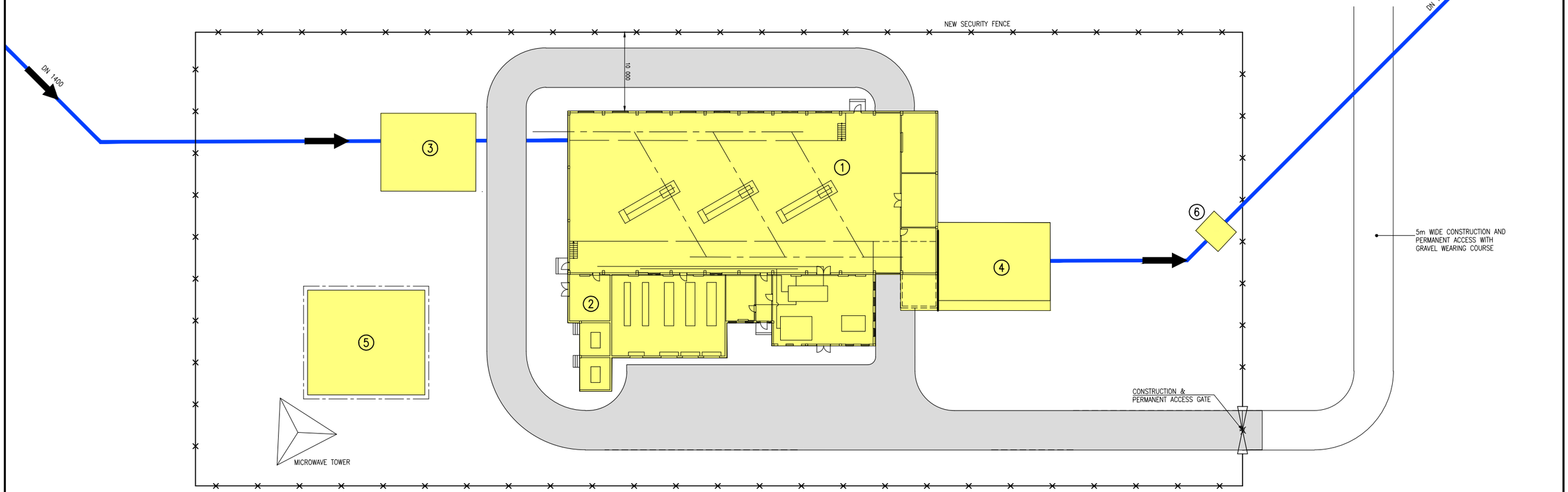
APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.: 2485.00.AAA.10.A004 | VERSION: A.0

2485.00.AAA.10.A004

LEGEND

- DN 1400 GARIEP PIPELINE
- ① PUMP HOUSE
- ② MCC
- ③ SUCTION VALVE CHAMBER.
- ④ DELIVERY VALVE CHAMBER.
- ⑤ STORE
- ⑥ ULTRASONIC FLOWMETER INSTALLATION.
- NEW FENCE



AS-BUILT RECORD

CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER _____ DATE _____

VERSION/AMENDMENTS

No.	DATE	DESCRIPTION	AUTHORISED BY

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www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
TYPICAL LAYOUT
PUMPING STATION

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	1:250	ORIGINAL DRAWING SHEET SIZE:	A1

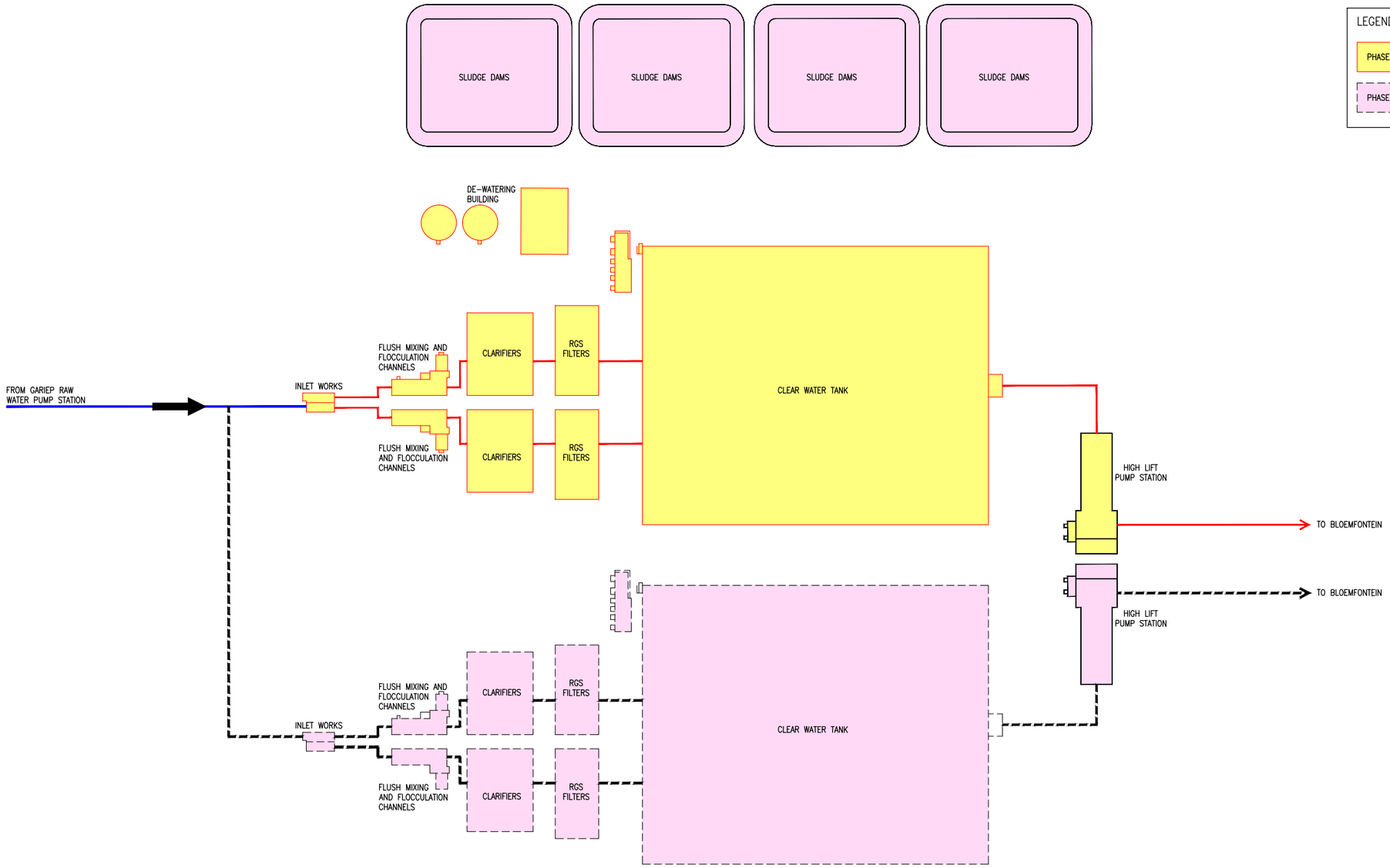
APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.:
CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	May 2015

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.: 2485.00.AAA.10.U001
VERSION: A.0

2485.00.AAA.10.U001



AS-BUILT RECORD

CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

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VERSION/AMENDMENTS

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Tel:+ 27 (0) 12 842 8700
Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:
TYPICAL LAYOUT WATER TREATMENT WORKS

MANGAUNG METRO MUNICIPALITY METRO MUNISIPALITEIT LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	1:1000	ORIGINAL DRAWING SHEET SIZE:	A1

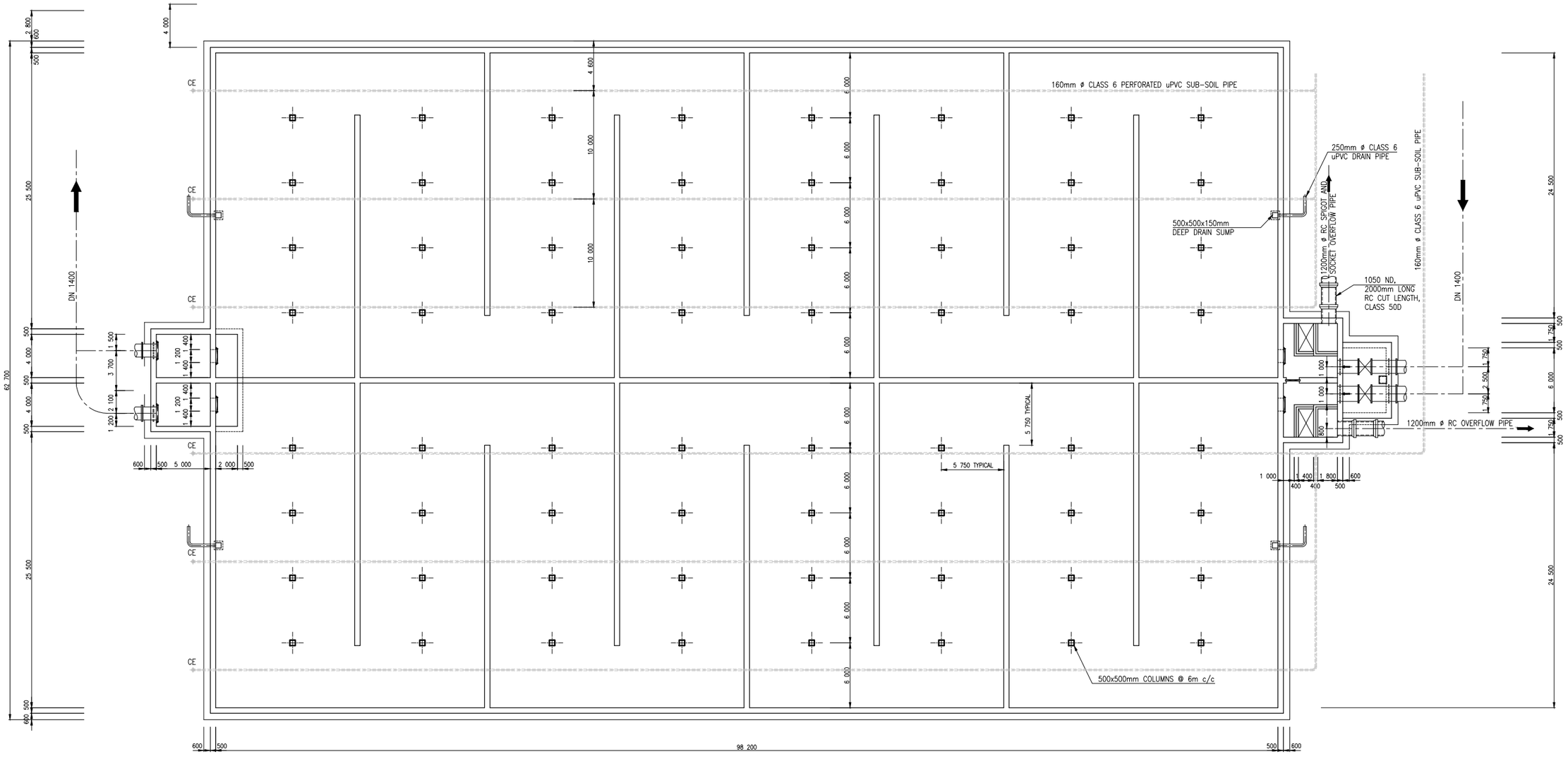
APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.:
CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	May 2015

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.: 2485.00.AAA.10.U002
VERSION: B.0

2485.00.AAA.10.U002



PLAN (ROOF SLAB REMOVED)

SCALE 1:200

AS-BUILT RECORD			
CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER DATE

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Tel:+ 27 (0) 12 842 8700
Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:

GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:

TYPICAL LAYOUT
STORAGE RESERVOIR

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	AS SHOWN	ORIGINAL DRAWING SHEET SIZE:	A1

APPROVED:

CLIENT OR ASSIGNEE: _____ DATE: _____

CLIENT DRAWING No.:	CLIENT REF No.:

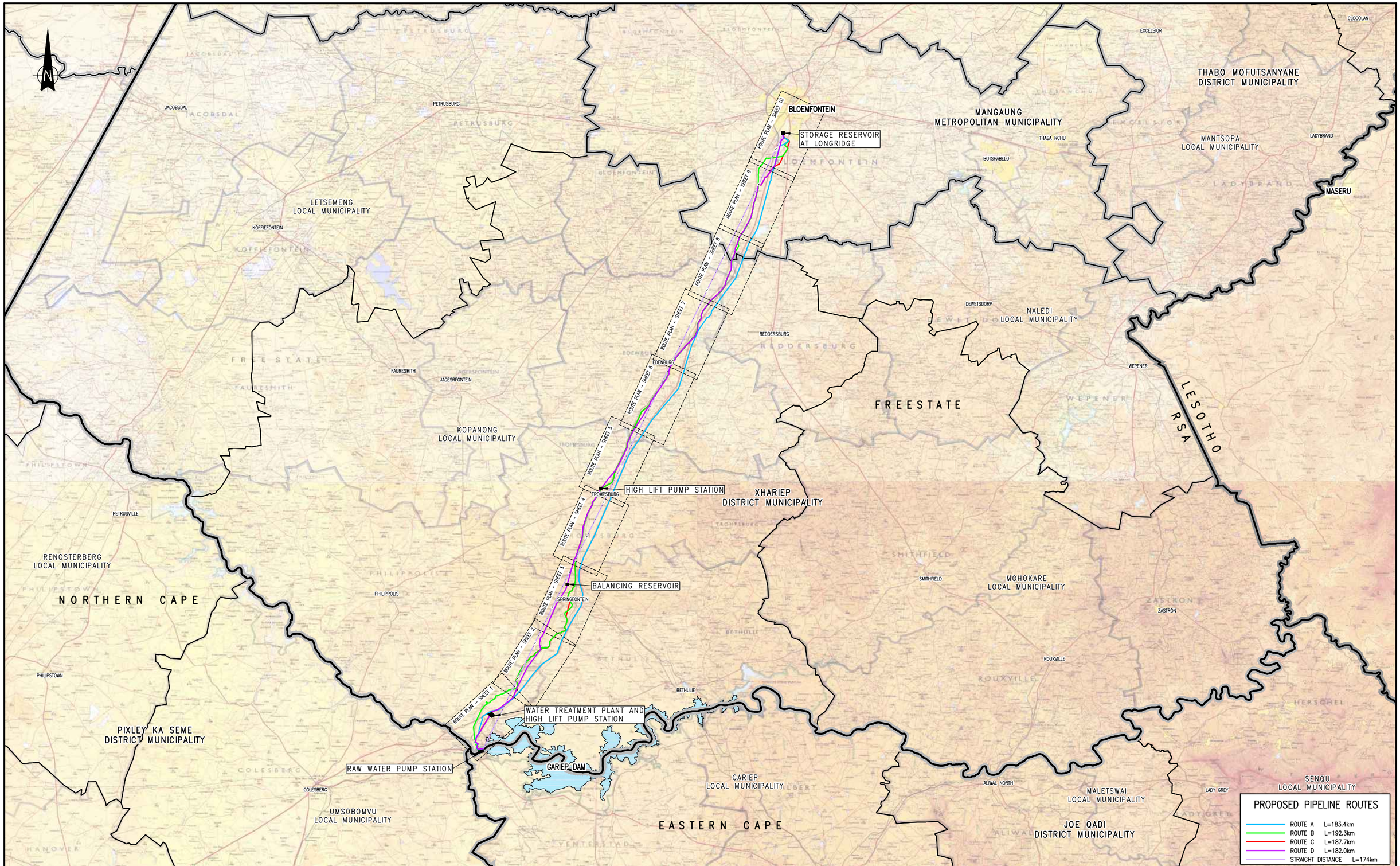
SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	May 2015

APPROVED ON BEHALF OF BIGEN AFRICA:

ENGINEER: _____ DATE: _____

DRAWING No.:	VERSION:
2485.00.AAA.10.U003	A.0

2485.00.AAA.10.U003



AS-BUILT RECORD

CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER _____ DATE _____

VERSION/AMENDMENTS

No.	DATE	DESCRIPTION	AUTHORISED BY

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The Innovation Hub Persequor Pretoria
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E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:

GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:

KEYPLAN

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	±1:400 000	ORIGINAL DRAWING SHEET SIZE:	A1

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	October 2014

APPROVED:

CLIENT OR ASSIGNEE: _____ DATE: _____

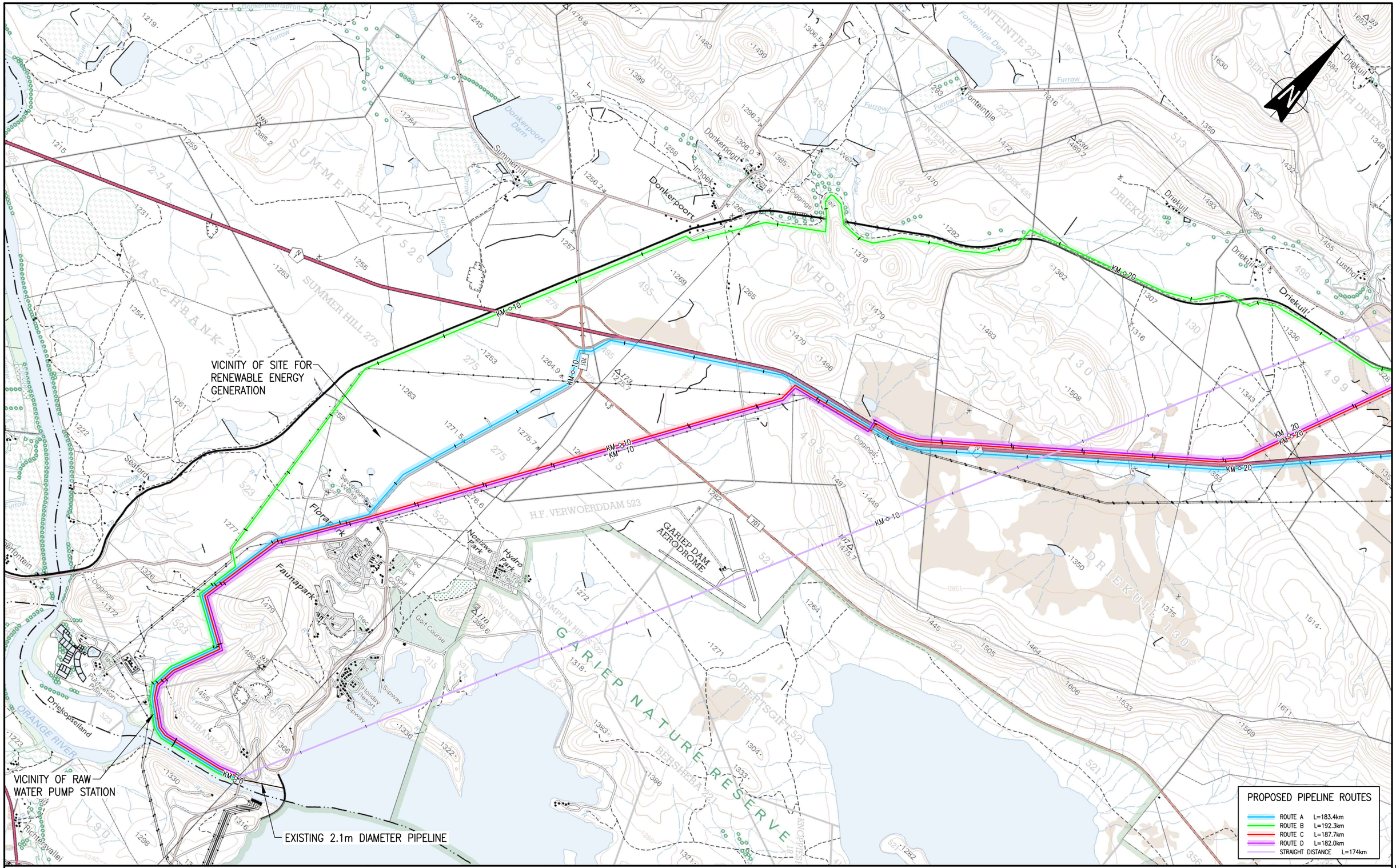
CLIENT DRAWING No.: CLIENT REF No.:

APPROVED ON BEHALF OF BIGEN AFRICA:

ENGINEER: _____ DATE: _____

DRAWING No.: 2485.00.GZA.05.S001 VERSION: D.0

2485.00.GZA.05.S001



AS-BUILT RECORD			
CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER _____ DATE _____

VERSION/AMENDMENTS			
No.	DATE	DESCRIPTION	AUTHORISED BY

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Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:
PIPELINE ROUTE PLAN SHEET 1

MANGAUNG METRO MUNICIPALITY METRO MUNISIPALITEIT LEKGOTLA LA MOTSE

0 50 100 — 100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	± 1:25 000	ORIGINAL DRAWING SHEET SIZE:	A1

APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.: | CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	October 2014

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____
DRAWING No.: 2485.00.GZA.05.U001 | VERSION: B.0

2485.00.GZA.05.U001

VICINITY OF WATER TREATMENT PLANT AND HIGH LIFT PUMP STATION

VICINITY OF SITE FOR RENEWABLE ENERGY GENERATION

KM 20

KM 30

KM 40

Old Rail Route

Priors

Driekuil

Lusthof

Faure

Vereeniging

Klipbankfontein

Bosrand

Hereford

Excelsior

Stockport

PROPOSED PIPELINE ROUTES

ROUTE A	L=183.4km
ROUTE B	L=192.3km
ROUTE C	L=187.7km
ROUTE D	L=182.0km
STRAIGHT DISTANCE	L=174km

AS-BUILT RECORD

CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER _____ DATE _____

VERSION/AMENDMENTS

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E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
PIPELINE ROUTE PLAN
SHEET 2

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE: ± 1:25 000
ORIGINAL DRAWING SHEET SIZE: A1

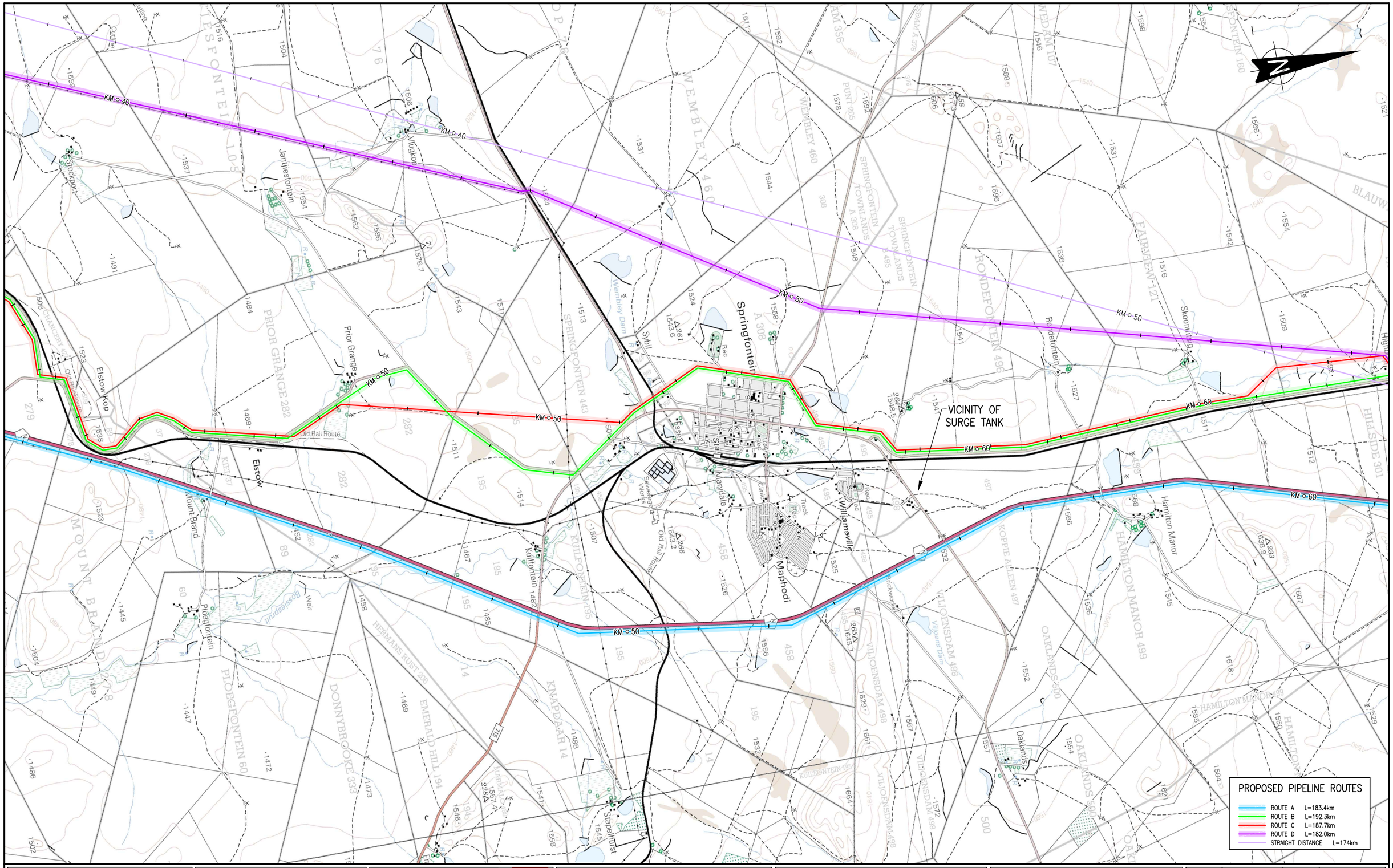
APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.:
CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	October 2014

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.: 2485.00.GZA.05.U002
VERSION: B.0

2485.00.GZA.05.U002



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ENGINEER _____ DATE _____

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www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:
PIPELINE ROUTE PLAN SHEET 3

MANGAUNG METRO MUNICIPALITY METRO MUNISIPALITEIT LEKGOTLA LA MOTSE

0 50 100 — 100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	± 1:25 000	ORIGINAL DRAWING SHEET SIZE:	A1

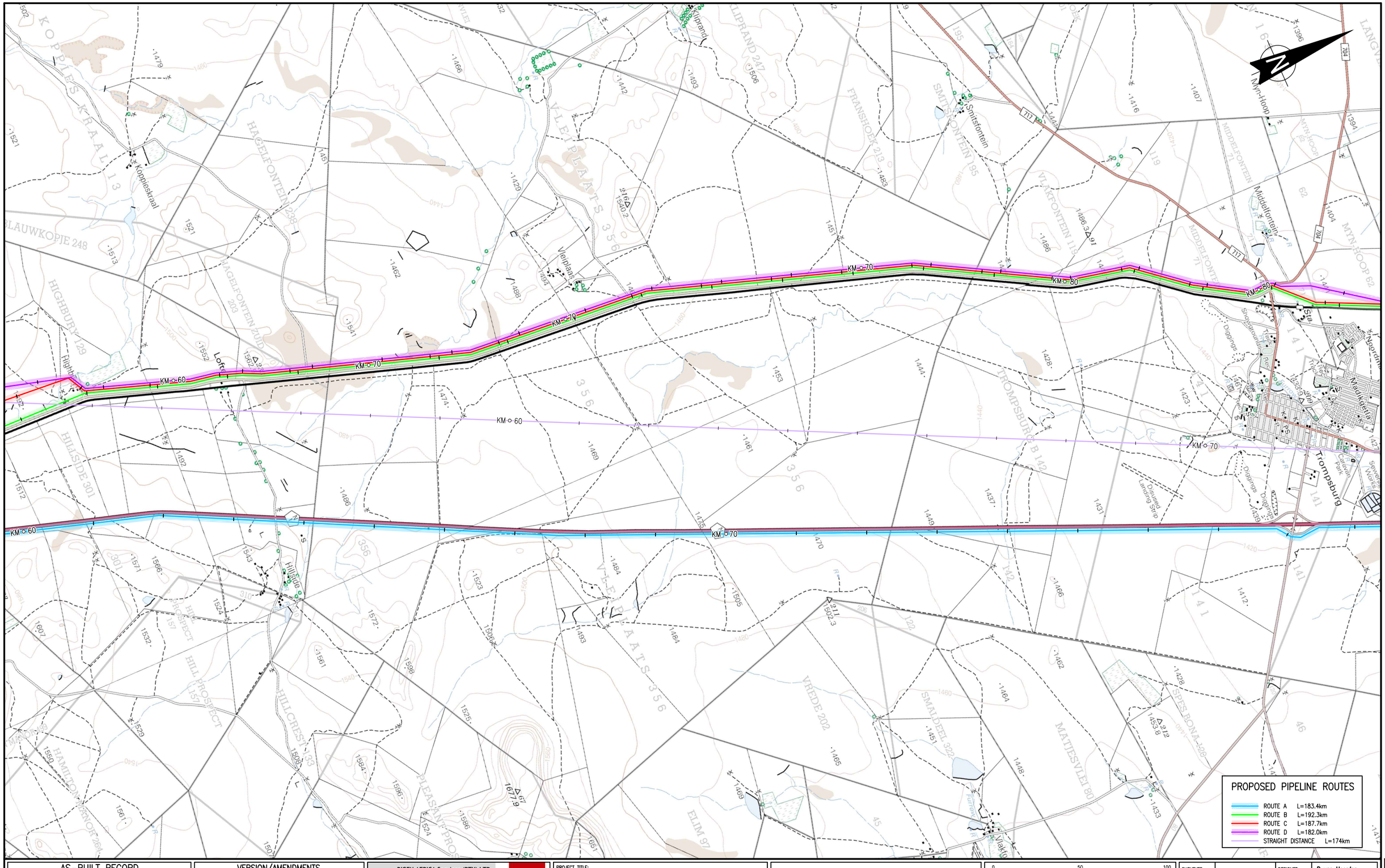
APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.: | CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	October 2014

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.: 2485.00.GZA.05.U003 | VERSION: B.0

2485.00.GZA.05.U003



AS-BUILT RECORD			
CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER DATE

VERSION/AMENDMENTS			
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www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
PIPELINE ROUTE PLAN
SHEET 4

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	± 1:25 000	ORIGINAL DRAWING SHEET SIZE:	A1

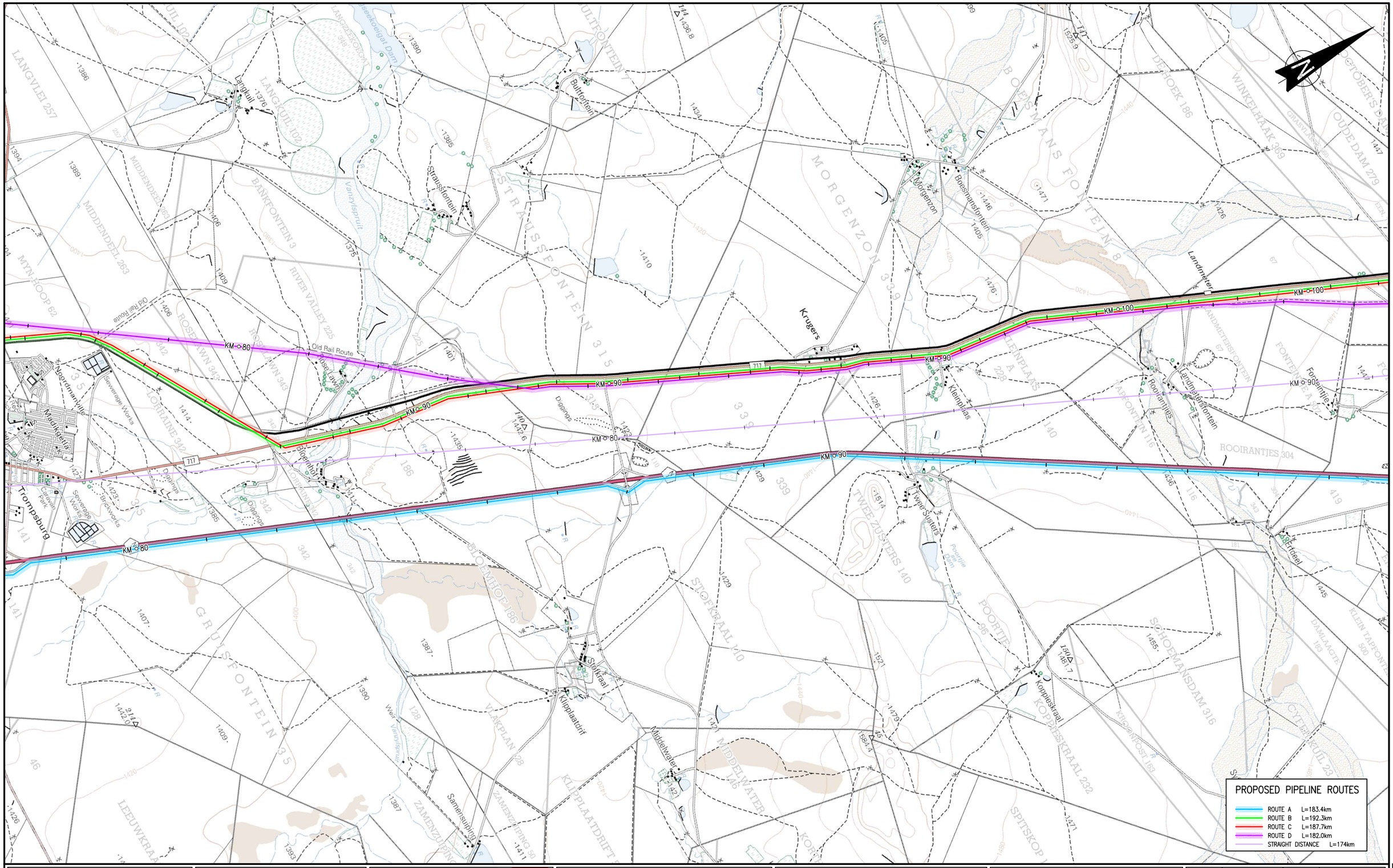
APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.:
CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	October 2014

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.: 2485.00.GZA.05.U004
VERSION: B.0

2485.00.GZA.05.U004



AS-BUILT RECORD			
CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER DATE

VERSION/AMENDMENTS			
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E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
PIPELINE ROUTE PLAN
SHEET 5

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	± 1:25 000	ORIGINAL DRAWING SHEET SIZE:	A1

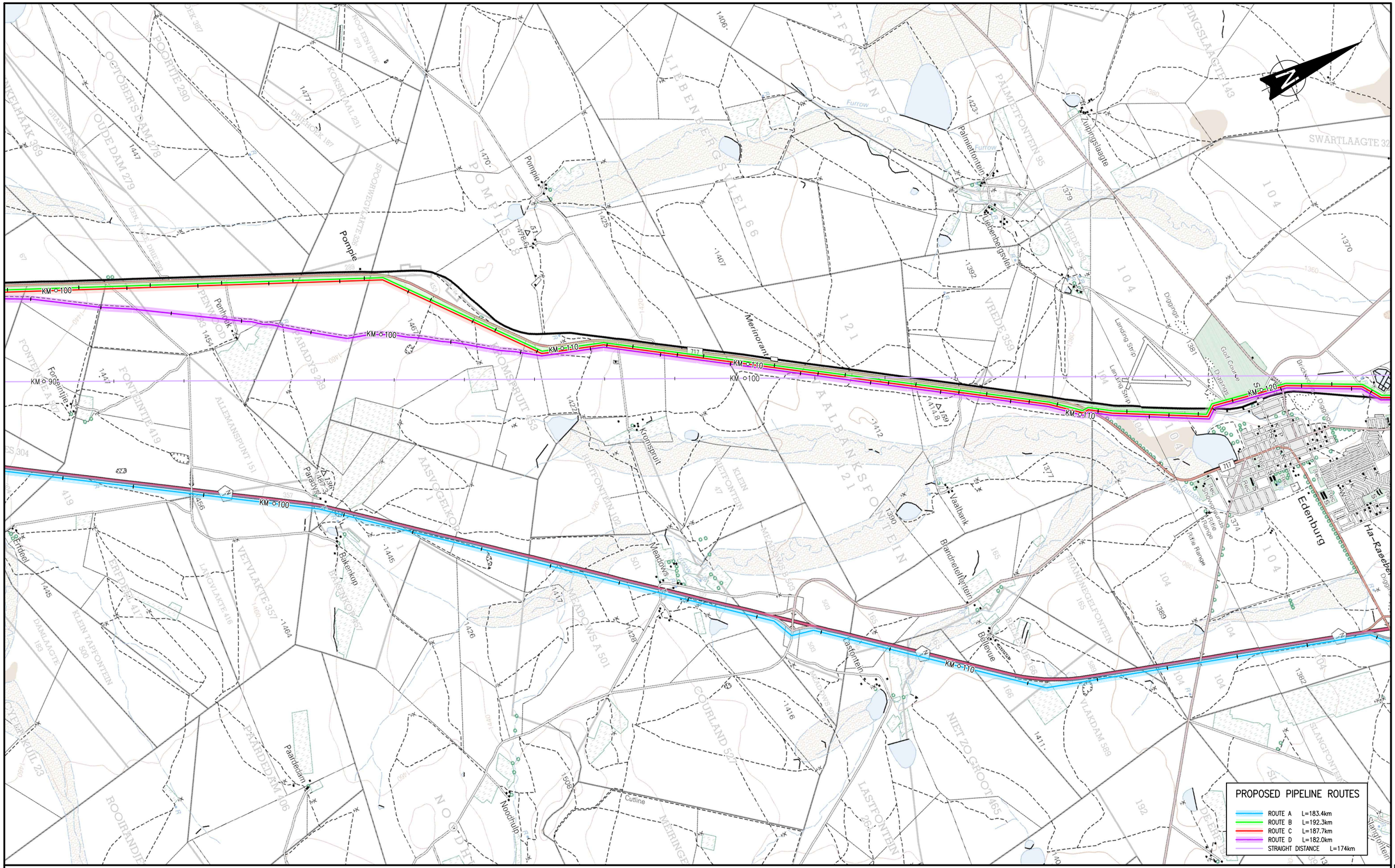
APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.: CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	October 2014

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.: 2485.00.GZA.05.U005
VERSION: B.0

2485.00.GZA.05.U005



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CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER _____ DATE _____

VERSION/AMENDMENTS

No.	DATE	DESCRIPTION	AUTHORISED BY

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Allan Cormack Street
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PO Box 29 The Innovation Hub Pretoria 0087
Tel:+ 27 (0) 12 842 8700
Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
PIPELINE ROUTE PLAN
SHEET 6

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE: ± 1:25 000
ORIGINAL DRAWING SHEET SIZE: A1

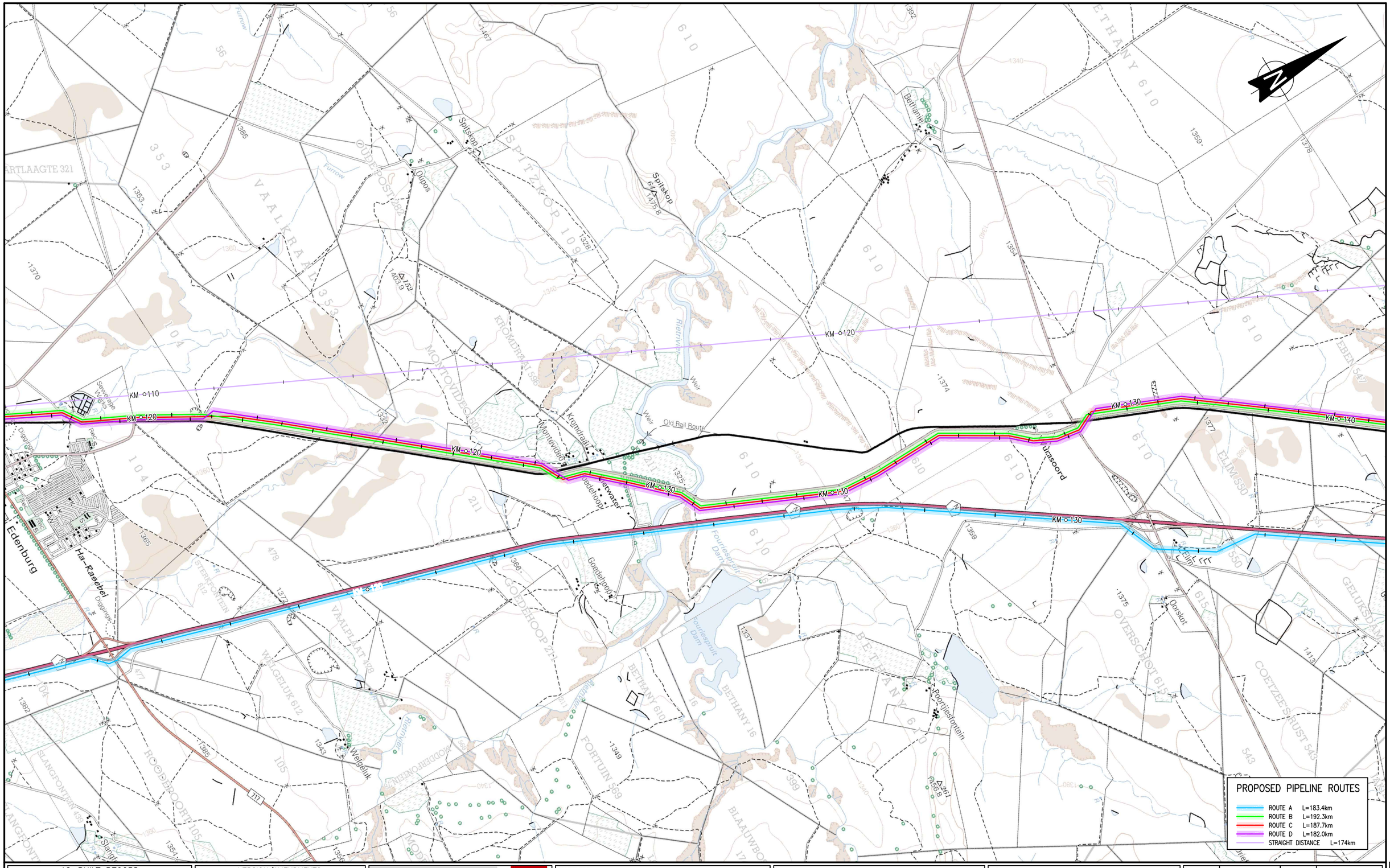
APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.:
CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	October 2014

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.: 2485.00.GZA.05.U006
VERSION: B.0

2485.00.GZA.05.U006



AS-BUILT RECORD

CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER _____ DATE _____

VERSION/AMENDMENTS

No.	DATE	DESCRIPTION	AUTHORISED BY

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Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:
PIPELINE ROUTE PLAN SHEET 7

MANGAUNG METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

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100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	± 1:25 000	ORIGINAL DRAWING SHEET SIZE:	A1

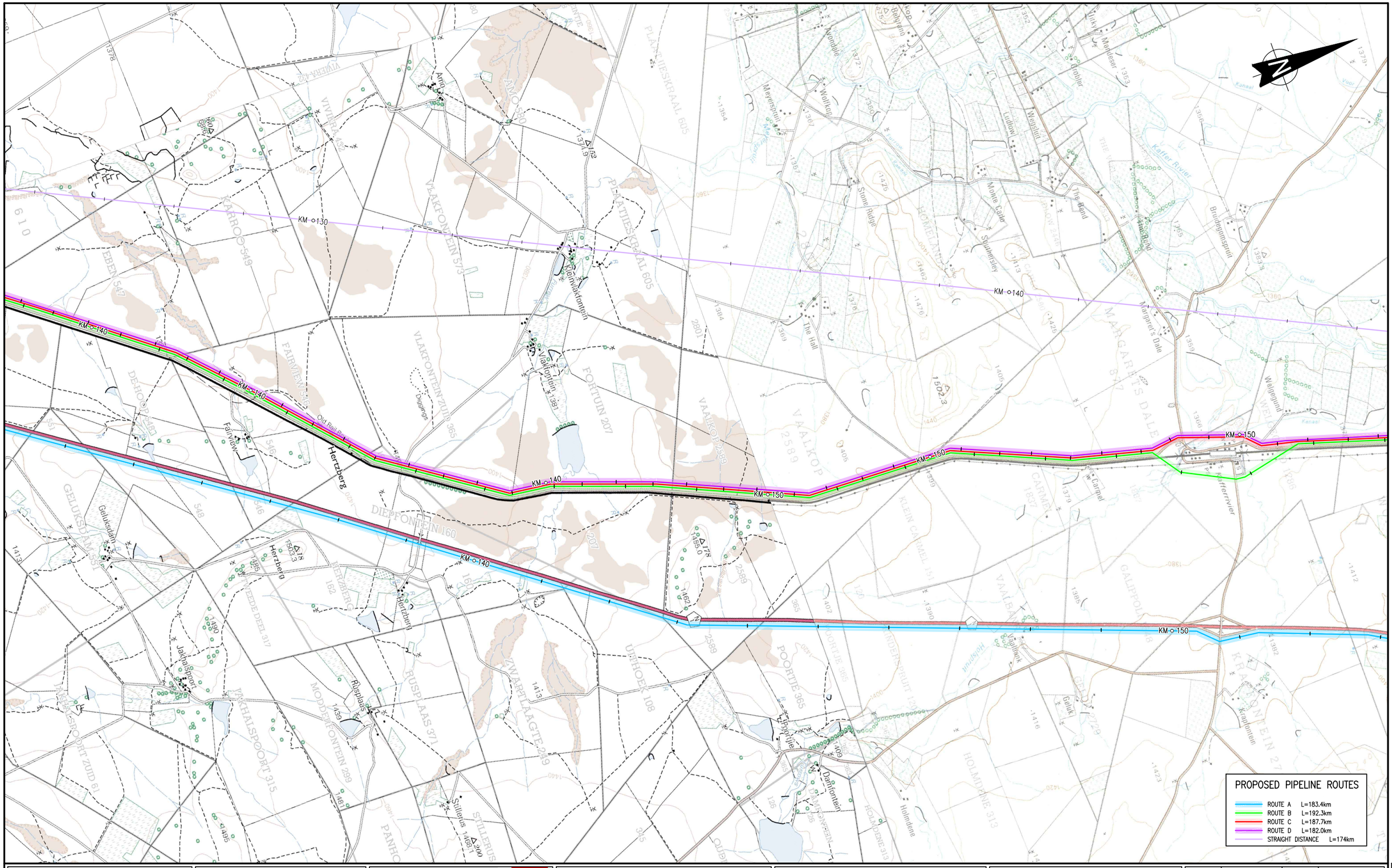
APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.: | CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	October 2014

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.: 2485.00.GZA.05.U007 | VERSION: B.0

2485.00.GZA.05.U007



AS-BUILT RECORD

CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

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Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:
PIPELINE ROUTE PLAN SHEET 8

MANGAUNG METRO MUNICIPALITY METRO MUNISIPALITEIT LEKGOTLA LA MOTSE

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100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	± 1:25 000	ORIGINAL DRAWING SHEET SIZE:	A1

APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.: | CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	October 2014

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.: **2485.00.GZA.05.U008** VERSION: **B.0**

2485.00.GZA.05.U008

AS-BUILT RECORD			
CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER DATE

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Tel:+ 27 (0) 12 842 8700
Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:

GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:

PIPELINE ROUTE PLAN SHEET 9

MANGAUNG METRO MUNICIPALITY METRO MUNISIPALITEIT LEKGOTLA LA MOTSE

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ORIGINAL DRAWING SCALE:	± 1:25 000	ORIGINAL DRAWING SHEET SIZE:	A1

APPROVED:

CLIENT OR ASSIGNEE: _____ DATE: _____

CLIENT DRAWING No.: CLIENT REF No.:

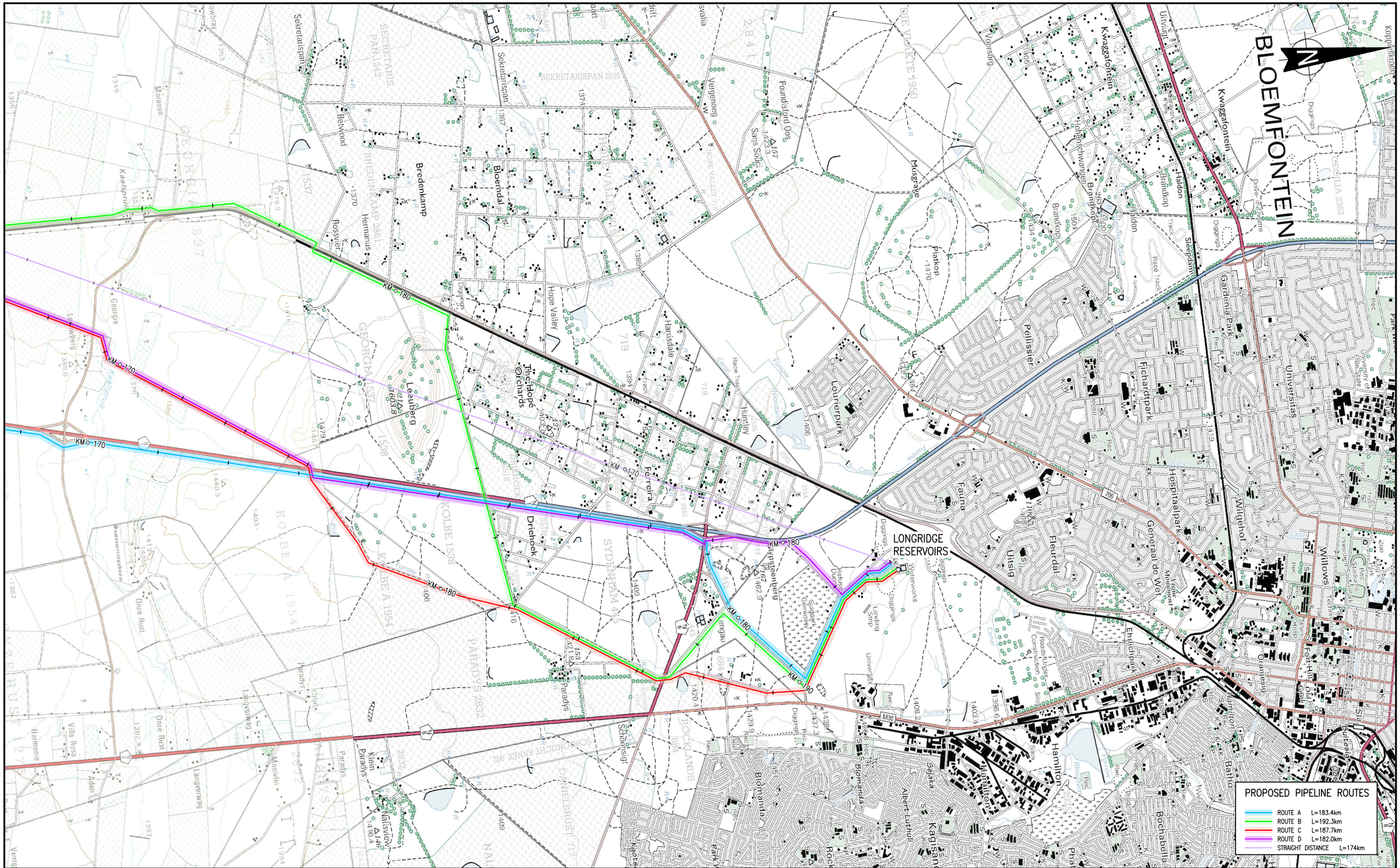
SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	October 2014

APPROVED ON BEHALF OF BIGEN AFRICA:

ENGINEER: _____ DATE: _____

DRAWING No.:	VERSION:
2485.00.GZA.05.U009	B.0

2485.00.GZA.05.U009



AS-BUILT RECORD			
CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER _____ DATE _____

VERSION/AMENDMENTS			
No.	DATE	DESCRIPTION	AUTHORISED BY

BIGEN AFRICA Services (PTY) LTD
Allan Cormack Street
The Innovation Hub Persequor Pretoria
PO Box 29 The Innovation Hub Pretoria 0087
Tel:+ 27 (0) 12 842 8700
Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:
PIPELINE ROUTE PLAN SHEET 10

MANGAUNG METRO MUNICIPALITY METRO MUNISIPALITEIT LEKGOTLA LA MOTSE

100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	± 1:25 000	ORIGINAL DRAWING SHEET SIZE:	A1

APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.:
CLIENT REF No.:

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
CO-ORDINATE SYSTEM:		DATE:	October 2014

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.: 2485.00.GZA.05.U010 VERSION: B.0

2485.00.GZA.05.U010

LEGEND

- 66kV
- BLUE — 132kV
- LIGHT BLUE — N1
- ORANGE — RURAL NETWORK
- PIPELINE POWER
- TAKE-OFFS (PROPOSED)

AS-BUILT RECORD

CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER DATE

VERSION/AMENDMENTS

No.	DATE	DESCRIPTION	AUTHORISED BY

BIGEN AFRICA Services (PTY) LTD
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The Innovation Hub Persequor Pretoria
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PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
BULK ELECTRICITY SUPPLIES

MANGAUNG
METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	N.T.S	ORIGINAL DRAWING SHEET SIZE:	A1

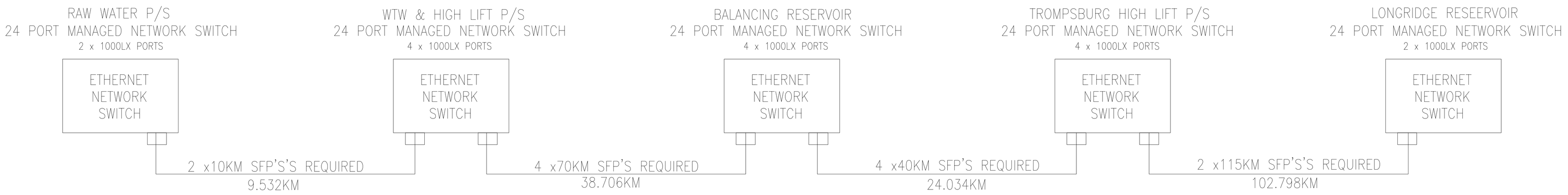
APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.: | CLIENT REF No.:

SURVEYED		DESIGNED	M. LOWE
DRAWN	S. MAWILA	CHECKED	M. LOWE
CO-ORDINATE SYSTEM:		DATE:	MAY 2015

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.:	VERSION:
2485.00.VA.00.U001	0.0

2485.00.VA.00.U001



9/125µm SINGLEMODE FIBER OPTIC CABLE ARMOURED 1310nm/1550nm

AS-BUILT RECORD

CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER DATE

VERSION/AMENDMENTS

No.	DATE	DESCRIPTION	AUTHORISED BY

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BIGEN AFRICA Engineering solutions

Engineering Services | Management Consulting Services | Project Finance Services | Infrastructure Development Services

PROJECT TITLE:

GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:

PRIMARY FIBRE OPTIC NETWORK

MANGAUNG
METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

0 50 100
100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	N.T.S	ORIGINAL DRAWING SHEET SIZE:	A1

APPROVED:

CLIENT OR ASSIGNEE: _____ DATE: _____

CLIENT DRAWING No.:	CLIENT REF No.:

SURVEYED		DESIGNED	E. HANNIE
DRAWN	S. MAWILA	CHECKED	M. LOWE

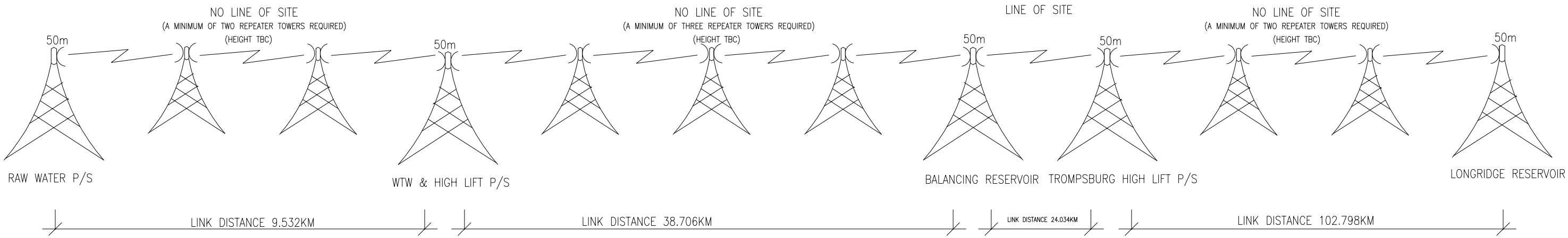
CO-ORDINATE SYSTEM:		DATE:	MAY 2015

APPROVED ON BEHALF OF BIGEN AFRICA:

ENGINEER: _____ DATE: _____

DRAWING No.:	VERSION:
2485.00.VA.00.U003	0.0

2485.00.VA.00.U003



AS-BUILT RECORD			
CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER DATE

VERSION/AMENDMENTS			
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Tel:+ 27 (0) 12 842 8700
Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
SECONDARY MICROWAVE
RADIO NETWORK

MANGAUNG
METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

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100mm ON ORIGINAL DRAWING

ORIGINAL DRAWING SCALE:	N.T.S	ORIGINAL DRAWING SHEET SIZE:	A1

APPROVED:
CLIENT OR ASSIGNEE: _____ DATE: _____
CLIENT DRAWING No.: | CLIENT REF No.:

SURVEYED		DESIGNED	E. HANNIE
DRAWN	S. MAWILA	CHECKED	M. LOWE
CO-ORDINATE SYSTEM:		DATE:	MAY 2015

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: _____ DATE: _____

DRAWING No.:	VERSION:
2485.00.VA.00.U002	0.0

2485.00.VA.00.U002

Annexure B – Water balance calculations

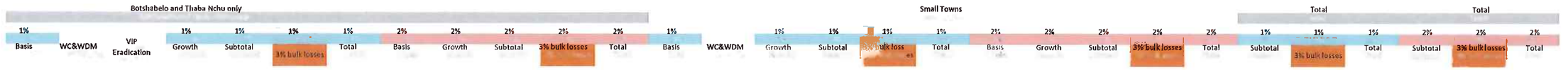
Garlep studie

Historic Water Consumtion Figures obtained from JOAT (million kl per annum)

Year	Bloem Water	Bloemfontein Maselspoort	Total	Botshabelo Bloem Water	Thaba Nchu Bloem Water	MMM Total	Small Towns	Greater Bloemfontein SubTotal	8% losses	TOTAL
2000	33.714	11 303	45.017	7.739	2.894	55.65		55.65	4.452	60.102
2001	35.361	12 311	47.672	6.332	2.477	56.481		56.481	4,51848	60.99948
2002	28.471	13.253	41.724	5 517	2.449	49.69		49.69	3.9752	53.6652
2003	33.266	14.391	47.657	6.96	3 859	58.476		58.476	4 67808	63.15408
2004	34.315	15.394	49.709	7.3	3 079	60.088		60 088	4.80704	64.89504
2005	35 332	15.863	51.195	7.59	3.277	62.062	1.587	63.649	5 09192	68 74092
2006	37.441	16.283	53.724	7.957	3.843	65.524	2.339	67,863	5,42904	73 29204
2007	39 654	19 876	59.53	8.491	3.906	71.927	3.011	74 938	5,99504	80.93304
2008	40.664	20.307	60.971	8 181	5.142	74.294	3 197	77.491	6,19928	83.69028
2009	35 833	30.132	65.965	9 209	4 637	79.811	3 294	83.105	6.6484	89.7534
2010	37.102	27.713	64.815	7 873	6.041	78.729	3.113	81 842	6.54736	88.38936
2011	37.914	22.72	60 634	10 06	6 298	76 992	2 524	79 516	6 36128	85.87728
2012	45.699	18 281	63.98	10.055	6.862	80.897	2 366	83 263	6 66104	89 92404
2013	48.955	16.821	65.776	11 29	8.427	85.493	2 108	87.601	7,00808	94.60908
2014										
2015										
2016										
2017										
2018										
2019										
2020										
2021										
2022										
2023										
2024										
2025										
2026										
2027										
2028										
2029										
2030										
2031										
2032										
2033										
2034										
2035										

Bloemfontein only

	1%				1%	1%	1%	1%	2%	2%	2%	2%	2%
	Basis	WC&WDM	New Developments	VIP Eradication	Growth	Subtotal	3% bulk losses	Total	Growth	Subtotal	3% bulk losses	Total	
						65.776	1.973	67 749		65 776	1 973	67.749	
	65.776	-1.409			0.644	65.010	1.950	66 960	65 776	1.287	65 654	1.970	67.623
	65.010	-1.409		0.2077	0 638	64.446	1.933	66.380	65.654	1 89	65.741	1.972	67.713
	64.446	-1.409		0.2077	0 632	63.877	1.916	65.793	65.741	1 91	65.830	1 975	67.805
	63.877	-1.409	2 9587	0.2077	0 656	66.290	1.989	68.279	65.830	1 52	68 939	2 068	71 007
	66.290	-1.409	2 9587	0.2077	0.680	68.728	2.062	70.790	68.939	1 414	72 110	2,163	74 273
	68.728	-1.409	2 9587	0.2077	0.705	71.190	2.136	73.325	72 110	1 477	75.344	2,260	77.604
	71.190	-1.409	2.9587	0.2077	0 729	73.676	2.210	75.886	75,344	1'542	78 643	2.359	81.002
	73.676				0 737	74.413	2.232	76.645	78 643	1 573	80 216	2,406	82.622
	74.413				0.744	75.157	2.255	77.412	80.216	1 604	81 820	2 455	84.275
	75.157				0.752	75.908	2.277	78.186	81.820	1.636	83 456	2 504	85.960
	75.908				0 759	76.667	2 300	78.967	83.456	1.669	85,125	2 554	87.679
	76.667				0.767	77.434	2.323	79.757	85.125	1.703	86.828	2.605	89.433
	77.434				0 774	78.208	2.346	80.555	86.828	1.737	88.565	2.657	91.221
	78.208				0.782	78.991	2.370	81.360	88.565	1 771	90.336	2,710	93.046
	78.991				0 790	79.780	2.393	82.174	90.336	1.807	92 143	2.764	94.907
	79.780				0 798	80.578	2.417	82.996	92.143	1 843	93 985	2 820	96.805
	80.578				0.806	81. 84	2.442	83,826	93.985	1 880	95.865	2 876	98 741
	81.384				0.814	82. 98	2.466	84.664	95.865	1 917	97.782	2 933	100.716
	82.198				0.822	83 020	2.491	85.510	97.782	1 956	99.738	2.992	102.730
	83.020				0.830	83. 50	2.516	86.366	99.738	1 995	101 733	3,052	104.785
	83.850				0 839	84 689	2.541	87.229	101 733	2 035	103.767	3 113	106.880
	84.689				0 847	85 535	2.566	88.102	103.767	2 075	105.843	3 175	109.018



				19.717	0 597	20 309			19 717	0.592	20.309				2.108	0.063	2.171			2.108	0 063	2.171	87.601	2.628	90.229	87.601	2.628	90.229
19.717	-0.423		0.193	19 487	0 585	20 072	19 717	0 386	19.680	0.590	20.271	2.108	-0.045	0.021	2.083	0.063	2.146	2 108	0.042	2.105	0.063	2.168	86.581	2.597	89.179	87.439	2.623	90.062
19.487	-0.423	0 896	0 200	20 161	0 605	20 766	19.680	0.403	20.557	0.617	21.174	2.083	-0.045	0.020	2.059	0.062	2.120	2.105	0.042	2.101	0.063	2 164	86.666	2.600	89.266	88.399	2.652	91.051
20.161	-0.423	0.896	0 206	20.841	0 625	21.466	20.557	0.421	21.451	0.644	22 095	2.059	-0.045	0 020	2.034	0.061	2.095	2.101	0.041	2 097	0.063	2.160	86.752	2.603	89.354	89.379	2.681	92 060
20.841	-0.423	0.896	0.213	21 528	0.646	22.173	21.451	0 439	22 364	0.671	23.035	2.034	-0.045	0 020	2 008	0.060	2.069	2.097	0.040	2.092	0.063	2.155	89 826	2.695	92 571	93.395	2 802	96 197
21.528	-0.423	0.896	0.220	22.221	0.667	22.888	22.364	0.457	23 294	0.699	23.993	2.008	-0.045	0.020	1.983	0 059	2.042	2 092	0.040	2 087	0.063	2.150	92.932	2.788	95.720	97.491	2.925	100.415
22.221	-0.423	0.896	0.227	22 922	0.688	23.610	23.294	0.475	24.243	0.727	24.970	1.983	-0.045	0.019	1.957	0.059	2.016	2.087	0.039	2 081	0.062	2.144	96.069	2.882	98.951	101.668	3.050	104.718
22.922	-0.423	0 896	0 234	23.630	0.709	24.339	24.243	0.494	25.211	0.756	25.968	1.957	-0.045	0.019	1.931	0.058	1.989	2 081	0.039	2 075	0.062	2.137	99.236	2.977	102.214	105.929	3.178	109.107
23.630			0 236	23 866	0.716	24.582	25.211	0.504	25.715	0.771	26.487	1.931		0.019	1.950	0.059	2.009	2.075	0.040	2 115	0.063	2 179	100.229	3.007	103.236	108.046	3.241	111.288
23.866			0.239	24 105	0 723	24.828	25.715	0 514	26.230	0.787	27.017	1.950		0.020	1.970	0.059	2.029	2.115	0.041	2 156	0 065	2 220	101.231	3.037	104.268	110 205	3.306	113 512
24.105			0.241	24 346	0.730	25.076	26 230	0.525	26 754	0 803	27.557	1.970		0.020	1.989	0.060	2.049	2.156	0.041	2.197	0.066	2 263	102.243	3.067	105.311	112.407	3 372	115.780
24.346			0.243	24 589	0.738	25 327	26 754	0.535	27.289	0 819	28 108	1.989		0.020	2.009	0.060	2.070	2.197	0.041	2.238	0.067	2.305	103.266	3.098	106 364	114.653	3 440	118.093
24.589			0.246	24.835	0.745	25.580	27.289	0.546	27.835	0.835	28 670	2.009		0.020	2.029	0 061	2.090	2 238	0 042	2.280	0.068	2.348	104.299	3.129	107.428	116.943	3.508	120.451
24.835			0.248	25 083	0.752	25.836	27.835	0.557	28 392	0.852	29.244	2.029		0.020	2.050	0.061	2.111	2 280	0.042	2 322	0.070	2 392	105.342	3.160	108.502	119.279	3.578	122.857
25.083			0 251	25 334	0.760	26.094	28.392	0.568	28.960	0.869	29.829	2.050		0.020	2.070	0.062	2.132	2 322	0 043	2 365	0.071	2 436	106.395	3.192	109 587	121.660	3.650	125.310
25.334			0.253	25.587	0.768	26 355	28.960	0.579	29 539	0.886	30.425	2.070		0.021	2.091	0.063	2.154	2.365	0.043	2.408	0.072	2 480	107.459	3.224	110.683	124.089	3.723	127.812
25.587			0 256	25.843	0.775	26 619	29 539	0 591	30.130	0 904	31 034	2.091		0.021	2 112	0.063	2.175	2.408	0.044	2.451	0.074	2 525	108.533	3.256	111 789	126 566	3.797	130.363
25.843			0 258	26.102	0 783	26 885	30.130	0.603	30.732	0 922	31 654	2 112		0.021	2 133	0.064	2.197	2.451	0.044	2.495	0.075	2.570	109.619	3.289	112 907	129.093	3 873	132.965
26.102			0.261	26.363	0.791	27.154	30.732	0.615	31.347	0.940	32.287	2.133		0.021	2 154	0 065	2 219	2 495	0.044	2.540	0.076	2.616	110.715	3.321	114.036	131 669	3.950	135.619
26.363			0.264	26.626	0.799	27.425	31.347	0.627	31.974	0.959	32.933	2.154		0.022	2.176	0.065	2.241	2 540	0.045	2.585	0.078	2.662	111.822	3.355	115.177	134.296	4.029	138.325
26.626			0.266	26.893	0 807	27.699	31.974	0.639	32.613	0.978	33.592	2.176		0.022	2 198	0.066	2.264	2.585	0.045	2 630	0 079	2 709	112.940	3 388	116.329	136.976	4.109	141.085
26.893			0 269	27.162	0.815	27.976	32.613	0.652	33.266	0.998	34.264	2.198		0.022	2 220	0.067	2.286	2.630	0.046	2.676	0.080	2 756	114 070	3.422	117.492	139.709	4.191	143.900
27.162			0.272	27.433	0 823	28.256	33 266	0.665	33.931	1 018	34.949	2.220		0.022	2 242	0.067	2.309	2.676	0.046	2.722	0.082	2 803	115 210	3 456	118.667	142.495	4.275	146.770

Gariep studie	1% growth				2% growth				1% growth				2% growth				Bloemfontein supply (average)			
	Projected average demand including 3% bulk supply system losses (Ml/day)				Projected average demand including 3% bulk supply system losses (Ml/day)				Projected peak demand including 3% bulk supply system losses (Ml/day)				Projected peak demand including 3% bulk supply system losses (Ml/day)							
Year	Bloemfontein	Botshabelo and Thaba Nchu	Small Towns	Total	Bloemfontein	Botshabelo and Thaba Nchu	Small Towns	Total	Bloemfontein	Botshabelo and Thaba Nchu	Small Towns	Total	Bloemfontein	Botshabelo and Thaba Nchu	Small Towns	Total	Maselspoort (130Ml/day future capacity)	Welbedacht (145Ml/day capacity)	Rustfontein (100Ml/day capacity)	Gariep (86Ml/day capacity)
2013	185.6	55.6	5.9	247.2	185.6	55.6	5.9	247.2	259.9	77.9	8.3	346.1	259.9	77.9	8.3	346.1	80	105.6		0
2014	183.5	55.0	5.9	244.3	185.3	55.5	5.9	246.7	256.8	77.0	8.2	342.1	259.4	77.8	8.3	345.4	80	105.3		0
2015	181.9	56.9	5.8	244.6	185.5	58.0	5.9	249.5	254.6	79.6	8.1	342.4	259.7	81.2	8.3	349.2	80	105.5		0
2016	180.3	58.8	5.7	244.8	185.8	60.5	5.9	252.2	252.4	82.3	8.0	342.7	260.1	84.7	8.3	353.1	80	105.8		0
2017	187.1	60.7	5.7	253.5	194.5	63.1	5.9	263.6	261.9	85.0	7.9	354.9	272.4	88.4	8.3	369.0	97.3	97.3		0
2018	193.9	62.7	5.6	262.2	203.5	65.7	5.9	275.1	271.5	87.8	7.8	367.1	284.9	92.0	8.2	385.2	101.7	101.7		0
2019	200.9	64.7	5.5	271.1	212.6	68.4	5.9	286.9	281.2	90.6	7.7	379.5	297.7	95.8	8.2	401.7	106.3	106.3		0
2020	207.9	66.7	5.4	280.0	221.9	71.1	5.9	298.9	291.1	93.4	7.6	392.1	310.7	99.6	8.2	418.5	111.0	111.0		0
2021	210.0	67.3	5.5	282.8	226.4	72.6	6.0	304.9	294.0	94.3	7.7	396.0	316.9	101.6	8.4	426.9	113.2	113.2		0
2022	212.1	68.0	5.6	285.7	230.9	74.0	6.1	311.0	296.9	95.2	7.8	399.9	323.2	103.6	8.5	435.4	115.4	115.4		0
2023	214.2	68.7	5.6	288.5	235.5	75.5	6.2	317.2	299.9	96.2	7.9	403.9	329.7	105.7	8.7	444.1	117.8	117.8		0
2024	216.3	69.4	5.7	291.4	240.2	77.0	6.3	323.5	302.9	97.1	7.9	408.0	336.3	107.8	8.8	453.0	120.1	120.1		0
2025	218.5	70.1	5.7	294.3	245.0	78.5	6.4	330.0	305.9	98.1	8.0	412.1	343.0	110.0	9.0	462.0	122.5	122.5		0
2026	220.7	70.8	5.8	297.3	249.9	80.1	6.6	336.6	309.0	99.1	8.1	416.2	349.9	112.2	9.2	471.2	125.0	125.0		0
2027	222.9	71.5	5.8	300.2	254.9	81.7	6.7	343.3	312.1	100.1	8.2	420.3	356.9	114.4	9.3	480.6	127.5	127.5		0
2028	225.1	72.2	5.9	303.2	260.0	83.4	6.8	350.2	315.2	101.1	8.3	424.5	364.0	116.7	9.5	490.2	130.0	130.0		0
2029	227.4	72.9	6.0	306.3	265.2	85.0	6.9	357.2	318.3	102.1	8.3	428.8	371.3	119.0	9.7	500.0	130.0	135.2		0.0
2030	229.7	73.7	6.0	309.3	270.5	86.7	7.0	364.3	321.5	103.1	8.4	433.1	378.7	121.4	9.9	510.0	130.0	138.0		2.6
2031	232.0	74.4	6.1	312.4	275.9	88.5	7.2	371.6	324.7	104.2	8.5	437.4	386.3	123.8	10.0	520.2	130.0	137.8		8.1
2032	234.3	75.1	6.1	315.6	281.5	90.2	7.3	379.0	328.0	105.2	8.6	441.8	394.0	126.3	10.2	530.6	130.0	137.7		13.7
2033	236.6	75.9	6.2	318.7	287.1	92.0	7.4	386.5	331.3	106.2	8.7	446.2	401.9	128.8	10.4	541.1	130.0	137.6		19.5
2034	239.0	76.6	6.3	321.9	292.8	93.9	7.6	394.2	334.6	107.3	8.8	450.7	410.0	131.4	10.6	551.9	130.0	137.4		25.4
2035	241.4	77.4	6.3	325.1	298.7	95.8	7.7	402.1	337.9	108.4	8.9	455.2	418.2	134.1	10.8	563.0	130.0	137.3		31.4

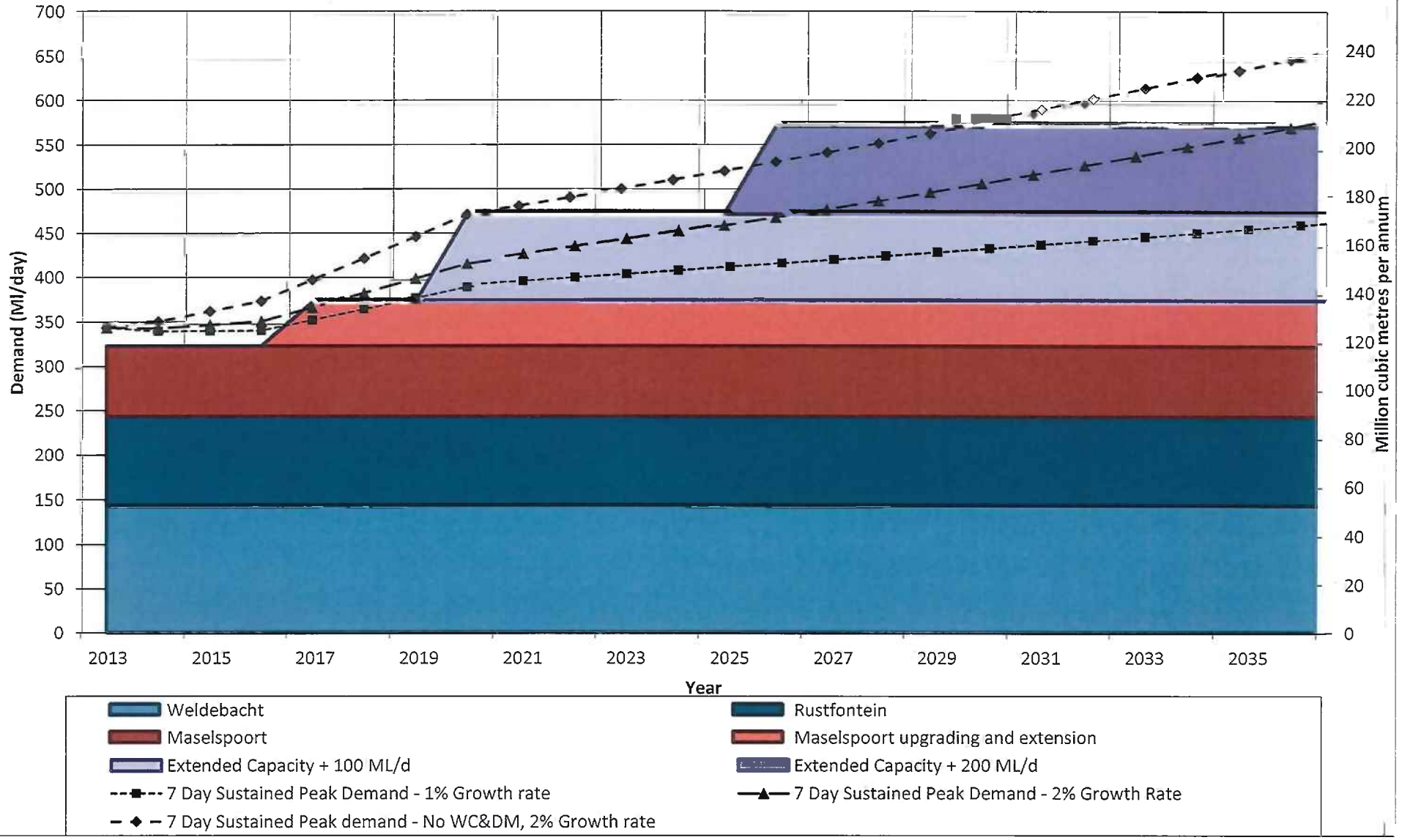
Cummulative supply to Bloemfontein (average)					Boshabelo and Thaba Nchu supply (average)		Cummulative supply to Bosh. and Thaba Nchu (average)			Greater Bloemfontein supply (average)				Cummulative supply to Greater Bloemfontein (average)				Existing capacity				No WCDM, 2% growth	
Welbedacht	Welbedacht + Rustfontein	Welbedacht + Rustfontein + Maselspoort	Gariep + Welbedacht + Rustfontein + Maselspoort	Shortfall	Rustfontein	Welbedacht	Rustfontein	Welbedacht	Shortfall	Welbedacht (145Ml/day	Rustfontein (100Ml/day	Maselspoort (130Ml/day future	Gariep (255Ml/day capacity)	Welbedacht	Welbedacht + Rustfontein	Welbedacht + Rustfontein +	Gariep + Welbedacht + Rustfontein					AADD with Peak	
105.6	105.6	185.6		-259.9	55.6	0.0	55.6		-259.9	111.6	55.6	80.0		111.6	167.2	247.2		325	325	325	325	247.2	346.1
105.3	105.3	185.3		-256.8	55.5	0.0	55.5		-256.8	111.2	55.5	80.0		111.2	166.7	246.7		325	325	325	325	252.1	353.0
105.5	105.5	185.5		-254.6	58.0	0.0	58.0		-254.6	111.4	58.0	80.0		111.4	169.5	249.5		325	325	325	325	260.4	364.5
105.8	105.8	185.8		-252.4	60.5	0.0	60.5		-252.4	111.7	60.5	80.0		111.7	172.2	252.2		325	325	325	325	268.8	376.3
97.3	97.3	194.5		-261.9	63.1	0.0	63.1		-261.9	103.2	63.1	97.3		103.2	166.3	263.6		325	375	375	375	285.8	400.1
101.7	101.7	203.5		-271.5	65.7	0.0	65.7		-271.5	107.6	65.7	101.7		107.6	173.4	275.1		325	375	375	375	303.2	424.5
106.3	106.3	212.6	212.6	-68.6	68.4	0.0	68.4		-281.2	112.2	68.4	106.3		112.2	180.6	286.9	286.9	325	375	375	375	321.0	449.4
111.0	111.0	221.9	221.9	-69.1	71.1	0.0	71.1		-291.1	116.8	71.1	111.0	0.0	116.8	188.0	298.9	298.9	325	475	475	375	339.1	474.7
113.2	113.2	226.4	226.4	-67.6	72.6	0.0	72.6		-294.0	119.1	72.6	113.2	0.0	119.1	191.7	304.9	304.9	325	475	475	375	345.9	484.2
115.4	115.4	230.9	230.9	-66.0	74.0	0.0	74.0		-296.9	121.5	74.0	115.4	0.0	121.5	195.5	311.0	311.0	325	475	475	375	352.8	493.9
117.8	117.8	235.5	235.5	-64.4	75.5	0.0	75.5		-299.9	124.0	75.5	117.8	0.0	124.0	199.5	317.2	317.2	325	475	475	375	359.9	503.8
120.1	120.1	240.2	240.2	-62.7	77.0	0.0	77.0		-302.9	126.4	77.0	120.1	0.0	126.4	203.4	323.5	323.5	325	475	475	375	367.1	513.9
122.5	122.5	245.0	245.0	-60.9	78.5	0.0	78.5		-305.9	128.9	78.5	122.5	0.0	128.9	207.5	330.0	330.0	325	475	475	375	374.4	524.2
125.0	125.0	249.9	249.9	-59.1	80.1	0.0	80.1		-309.0	131.5	80.1	125.0	0.0	131.5	211.6	336.6	336.6	325	475	575	375	381.9	534.6
127.5	127.5	254.9	254.9	-57.1	81.7	0.0	81.7		-312.1	134.1	81.7	127.5	0.0	134.1	215.9	343.3	343.3	325	475	575	375	389.5	545.3
130.0	130.0	260.0	260.0	-55.2	83.4	0.0	83.4		-315.2	136.8	83.4	130.0	0.0	136.8	220.2	350.2	350.2	325	475	575	375	397.3	556.2
135.2	135.2	265.2	265.2	-53.1	85.0	0.0	85.0		-318.3	142.1	85.0	130.0	0.0	142.1	227.2	357.2	357.2	325	475	575	375	405.3	567.4
138.0	138.0	268.0	270.5	-51.0	86.7	0.0	86.7		-321.5	145.0	86.7	130.0	2.6	145.0	231.7	361.7	364.3	325	475	575	375	413.4	578.7
137.8	137.8	267.8	275.9	-48.8	88.5	0.0	88.5		-324.7	145.0	88.5	130.0	8.1	145.0	233.5	363.5	371.6	325	475	575	375	421.6	590.3
137.7	137.7	267.7	281.5	-46.5	90.2	0.0	90.2		-328.0	145.0	90.2	130.0	13.7	145.0	235.2	365.2	379.0	325	475	575	375	430.1	602.1
137.6	137.6	267.6	287.1	-44.2	92.0	0.0	92.0		-331.3	145.0	92.0	130.0	19.5	145.0	237.0	367.0	386.5	325	475	575	375	438.7	614.1
137.4	137.4	267.4	292.8	-41.8	93.9	0.0	93.9		-334.6	145.0	93.9	130.0	25.4	145.0	238.9	368.9	394.2	325	475	575	375	447.4	626.4
137.3	137.3	267.3	298.7	-39.2	95.8	0.0	95.8		-337.9	145.0	95.8	130.0	31.4	145.0	240.8	370.8	402.1	325	475	575	375	456.4	638.9

Gariep studie

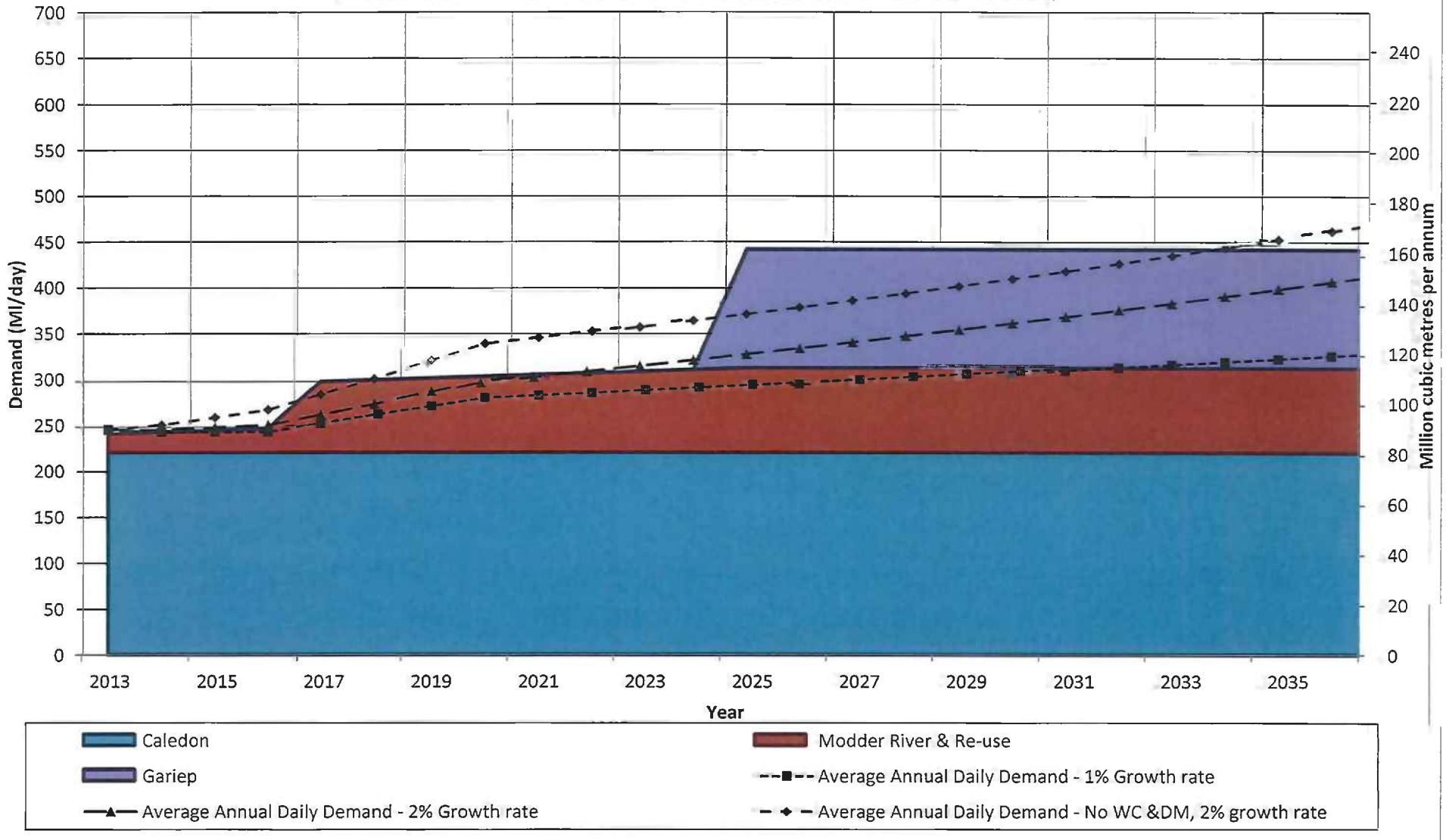
Year	Projected average demand including 3% bulk supply system losses (Ml/day)				Projected peak demand including 3% bulk supply system losses (Ml/day)				Bloemfontein supply (peak)				Cummulative supply to Bloemfontein (peak)				
	Bloemfontein	Botshabelo and Thaba Nchu	Small Towns	Total	Bloemfontein	Botshabelo and Thaba Nchu	Small Towns	Total	Maselspoort (130Ml/day future capacity)	Welbedacht (145Ml/day capacity)	Rustfontein (100Ml/day capacity)	Gariep (255Ml/day capacity)	Welbedacht	Welbedacht + Rustfontein	Welbedacht + Rustfontein + Maselspoort	Gariep + Welbedacht + Rustfontein + Maselspoort	Shortfall
2013	185.6	55.6	5.9	247.2	259.9	77.9	8.3	346.1	90.0	139.1	22.1	0.0	139.1	161.2	251.2		-259.9
2014	183.5	55.0	5.9	244.3	256.8	77.0	8.2	342.1	90.0	136.8	23.0	0.0	136.8	159.8	249.8		-256.8
2015	181.9	56.9	5.8	244.6	254.6	79.6	8.1	342.4	90.0	136.9	20.4	0.0	136.9	157.2	247.2		-254.6
2016	180.3	58.8	5.7	244.8	252.4	82.3	8.0	342.7	90.0	137.0	17.7	0.0	137.0	154.6	244.6		-252.4
2017	187.1	60.7	5.7	253.5	261.9	85.0	7.9	354.9	109.9	137.1	15.0	0.0	137.1	152.0	261.9		-261.9
2018	193.9	62.7	5.6	262.2	271.5	87.8	7.8	367.1	122.1	137.2	12.2	0.0	137.2	149.4	271.5		-271.5
2019	200.9	64.7	5.5	271.1	281.2	90.6	7.7	379.5	140.0	137.3	9.4	0.0	137.3	146.7	286.7	286.7	5.5
2020	207.9	66.7	5.4	280.0	291.1	93.4	7.6	392.1	140.0	0.0	0.0	151.1	0.0	0.0	140.0	291.1	0.0
2021	210.0	67.3	5.5	282.8	294.0	94.3	7.7	396.0	140.0	-6.0	0.0	160.0	-6.0		134.0	294.0	0.0
2022	212.1	68.0	5.6	285.7	296.9	95.2	7.8	399.9	140.0	-3.1	0.0	160.0	-3.1		136.9	296.9	0.0
2023	214.2	68.7	5.6	288.5	299.9	96.2	7.9	403.9	140.0	-0.1		160.0	-0.1		139.9	299.9	0.0
2024	216.3	69.4	5.7	291.4	302.9	97.1	7.9	408.0	140.0	2.9		160.0	2.9		142.9	302.9	0.0
2025	218.5	70.1	5.7	294.3	305.9	98.1	8.0	412.1	140.0	5.9		160.0	5.9		145.9	305.9	0.0
2026	220.7	70.8	5.8	297.3	309.0	99.1	8.1	416.2	140.0	9.0		160.0	9.0		149.0	309.0	0.0
2027	222.9	71.5	5.8	300.2	312.1	100.1	8.2	420.3	140.0	12.1		160.0	12.1		152.1	312.1	0.0
2028	225.1	72.2	5.9	303.2	315.2	101.1	8.3	424.5	140.0	15.2		160.0	15.2		155.2	315.2	0.0
2029	227.4	72.9	6.0	306.3	318.3	102.1	8.3	428.8	140.0	18.3		160.0	18.3		158.3	318.3	0.0
2030	229.7	73.7	6.0	309.3	321.5	103.1	8.4	433.1	140.0	21.5		160.0	21.5		161.5	321.5	0.0
2031	232.0	74.4	6.1	312.4	324.7	104.2	8.5	437.4	140.0	24.7		160.0	24.7		164.7	324.7	0.0
2032	234.3	75.1	6.1	315.6	328.0	105.2	8.6	441.8	140.0	28.0		160.0	28.0		168.0	328.0	0.0
2033	236.6	75.9	6.2	318.7	331.3	106.2	8.7	446.2	140.0	31.3		160.0	31.3		171.3	331.3	0.0
2034	239.0	76.6	6.3	321.9	334.6	107.3	8.8	450.7	140.0	34.6		160.0	34.6		174.6	334.6	0.0
2035	241.4	77.4	6.3	325.1	337.9	108.4	8.9	455.2	140.0	37.9		160.0	37.9		177.9	337.9	0.0

Boshabelo and Thaba Nchu supply (peak)		Cummulative supply to Bosh. and Thaba Nchu (peak)			Greater Bloemfontein supply (peak)				Cummulative supply to Greater Bloemfontein (peak)			
Rustfontein	Welbedacht	Rustfontein	Welbedacht	Shortfall	Welbedacht (145Ml/day capacity)	Rustfontein (100Ml/day capacity)	Maselspoort (140Ml/day future capacity)	Gariep (255Ml/day capacity)	Welbedacht	Welbedacht + Rustfontein	Welbedacht + Rustfontein + Maselspoort	Gariep + Welbedacht + Rustfontein + Maselspoort
77.9	0.0	77.9		-259.9	147.4	100.0	90.0		147.4	247.4	337.4	
77.0	0.0	77.0		-256.8	145.0	100.0	90.0		145.0	245.0	335.0	
79.6	0.0	79.6		-254.6	145.0	100.0	90.0		145.0	245.0	335.0	
82.3	0.0	82.3		-252.4	145.0	100.0	90.0		145.0	245.0	335.0	
85.0	0.0	85.0	85.0	-176.8	145.0	100.0	109.9		145.0	245.0	354.9	
87.8	0.0	87.8	87.8	-183.7	145.0	100.0	122.1		145.0	245.0	367.1	
90.6	0.0	90.6	90.6	-190.7	145.0	100.0	140.0		145.0	245.0	385.0	385.0
93.4	0.0	93.4	93.4	-197.7	7.6	93.4	140.0	151.1	7.6	101.0	241.0	392.1
94.3	0.0	94.3	94.3	-199.7	1.7	94.3	140.0	160.0	1.7	96.0	236.0	396.0
95.2	0.0	95.2	95.2	-201.7	4.7	95.2	140.0	160.0	4.7	99.9	239.9	399.9
100.0	-3.8	100.0	96.2	-203.7	3.9	100.0	140.0	160.0	3.9	103.9	243.9	403.9
100.0	-2.9	100.0	97.1	-205.7	8.0	100.0	140.0	160.0	8.0	108.0	248.0	408.0
100.0	-1.9	100.0	98.1	-207.8	12.1	100.0	140.0	160.0	12.1	112.1	252.1	412.1
100.0	-0.9	100.0	99.1	-209.9	16.2	100.0	140.0	160.0	16.2	116.2	256.2	416.2
100.0	0.1	100.0	100.1	-212.0	20.3	100.0	140.0	160.0	20.3	120.3	260.3	420.3
100.0	1.1	100.0	101.1	-214.1	24.5	100.0	140.0	160.0	24.5	124.5	264.5	424.5
100.0	2.1	100.0	102.1	-216.2	28.8	100.0	140.0	160.0	28.8	128.8	268.8	428.8
100.0	3.1	100.0	103.1	-218.4	33.1	100.0	140.0	160.0	33.1	133.1	273.1	433.1
100.0	4.2	100.0	104.2	-220.6	37.4	100.0	140.0	160.0	37.4	137.4	277.4	437.4
100.0	5.2	100.0	105.2	-222.8	41.8	100.0	140.0	160.0	41.8	141.8	281.8	441.8
100.0	6.2	100.0	106.2	-225.0	46.2	100.0	140.0	160.0	46.2	146.2	286.2	446.2
100.0	7.3	100.0	107.3	-227.3	50.7	100.0	140.0	160.0	50.7	150.7	290.7	450.7
100.0	8.4	100.0	108.4	-229.5	55.2	100.0	140.0	160.0	55.2	155.2	295.2	455.2

PROJECTED 7-DAY SUSTAINED PEAK DEMANDS (GREATER BLOEMFONTEIN AND SMALL TOWNS)



PROJECTED AVERAGE ANNUAL DAILY DEMANDS (GREATER BLOEMFONTEIN AND SMALL TOWNS)



Annexure C – Detailed project work breakdown structure

Mangaung Metro Municipality (MMM) Bulk Water Supply & Sanitation Programme

1. Internal Sanitation System Upgrades (Bloemspruit)

- 1.1 Infrastructure
  - 1.1.1. Inlet Works Upgrade
  - 1.1.2. Primary Settling Tank (PST) Upgrade
  - 1.1.3. Biofilter Upgrade
  - 1.1.4. Secondary Settling Tank (SST) Upgrade
  - 1.1.5. Digester Upgrade
  - 1.1.6. Improved Biological Nutrient Removal Upgrade
  - 1.1.7. Tertiary Treatment Upgrade
- 1.2 Services
- 1.3 Investigations
  - 1.3.1. Abstraction
  - 1.3.2. Topographical
  - 1.3.3. Geotechnical
  - 1.3.4. Environmental impact
  - 1.3.5. Water use
  - 1.3.6. Land use/servitudes
  - 1.3.7. Economic impact
  - 1.3.8. Power supply
- 1.4 Project Management

2. Internal Transfer System Upgrades

- 2.1 Infrastructure
  - 2.1.1. Bloemspruit Transfer Pipeline
    - 2.1.1.1. North Eastern to Mockes Dame Pipeline
    - 2.1.1.2. Bloemspruit to Mockes Dam Pipeline
  - 2.1.2. North Eastern Transfer Pipeline
- 2.2 Services
  - 2.2.1. Bloemspruit Transfer Pipeline
    - 2.2.1.1. Early Warning System
  - 2.2.2. North Eastern Transfer Pipeline
- 2.3 Investigations
  - 2.3.1. Dam abstraction
  - 2.3.2. Topographical
  - 2.3.3. Geotechnical
  - 2.3.4. Environmental impact
  - 2.3.5. Water use
  - 2.3.6. Land use/servitudes
  - 2.3.7. Economic impact
  - 2.3.8. Power supply
- 2.4 Project Management

3. Internal Storage Systems Upgrades

- 3.1 Infrastructure
  - 3.1.1. Mockes Dam Wall increase
  - 3.1.2. Mockes Dam safety repairs
- 3.2 Services
- 3.3 Investigations
  - 3.3.1. Dam abstraction
  - 3.3.2. Topographical
  - 3.3.3. Geotechnical
  - 3.3.4. Environmental impact
  - 3.3.5. Water use
  - 3.3.6. Land use/servitudes
  - 3.3.7. Economic impact
  - 3.3.8. Power supply
- 3.4 Project Management

4. Internal Potable Water Treatment System Upgrades

- 4.1 Infrastructure
  - 4.1.1 Refurbishment & De-bottleneck
  - 4.1.2 Dissolved Air Floatation (DAF) Upgrade
  - 4.1.3. Advanced Treatment ozone
  - 4.1.4 Advanced Treatment GAC
  - 4.1.5. Sludge management system
  - 4.1.6 Supernatant recovery system
  - 4.1.7 Wash water recovery system
- 4.2 Services
  - 4.2.1. Refurbishment & De-bottleneck
    - 4.2.1.1. Control, Communications & SCADA
    - 4.2.1.2. Exposing of Services and Surveying
  - 4.2.2. DAF Upgrade
    - 4.2.2.1 MCC Upgrades
  - 4.2.3. Advanced Treatment Ozone
    - 4.2.3.1. MCC and LV Distribution Upgrade
  - 4.2.4. Advanced Treatment GAC
    - 4.2.4.1. MCC and LV Distribution Upgrade
- 4.3 Investigations
  - 4.3.1. Dam abstraction
  - 4.3.2. Topographical
  - 4.3.3. Geotechnical
  - 4.3.4 Environmental impact
  - 4.3.5 Water use
  - 4.3.6. Land use/servitudes
  - 4.3.7. Economic impact
  - 4.3.8. Power supply
- 4.4 Project Management

5. External Gariep Bulk Water System Project

- 5.1 Infrastructure
  - 5.1.1. Abstraction Works
  - 5.1.2. Low Lift Pumping Station
  - 5.1.3. Raw Water Main
  - 5.1.4. Water Treatment Works
  - 5.1.5. High Lift Pumping Station 1
  - 5.1.6. Delivery Main 1
  - 5.1.7. High Level Storage
  - 5.1.8. Gravity Main 1
  - 5.1.9. Gravity Main 2
  - 5.1.10. Booster Pumping Station
  - 5.1.11. Small Town Draw-off's
  - 5.1.12. Terminal Reservoir
  - 5.1.13. Down Stream Integration
  - 5.1.14. Cathodic Protection
- 5.2 Services
  - 5.2.1 Regional Control and Communication
  - 5.2.2 Bulk Power Supply
  - 5.2.3. Security
- 5.3 Investigations
  - 5.3.1. Dam abstraction
  - 5.3.2. Topographical
  - 5.3.3. Geotechnical
  - 5.3.4. Environmental impact
  - 5.3.5. Water use
  - 5.3.6. Land use/servitudes
  - 5.3.7. Radio path
  - 5.3.8. Economic impact
  - 5.3.9. Power supply
- 5.4 Project Management
  - 5.4.1. Feasibility
  - 5.4.2 Implementation
  - 5.4.3 Close-out

6. Programme Management

- 6.1 Feasibility
  - 6.1.1 Initiation
  - 6.1.2. Planning
  - 6.1.3 Execution
    - 6.1.3.1. Water & Sanitation Master Plan
    - 6.1.3.2 Programme Study Report
      - 6.1.3.2.1 Scoping
      - 6.1.3.2.2 Engineering
      - 6.1.3.2.3 Schedule development
      - 6.1.3.2.4 Estimation
      - 6.1.3.2.5 Risk Management
      - 6.1.3.2.6 Operational Readiness
    - 6.1.3.3. Programme Execution Plan
  - 6.1.4. Closing
  - 6.1.5. Assurance
- 6.2 Implementation
- 6.3 Close-out
- 6.4 Operate and Maintain

AS-BUILT RECORD

CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER DATE

VERSION/AMENDMENTS

No.	DATE	DESCRIPTION	AUTHORISED BY

BIGEN AFRICA Services (PTY) LTD
Allan Cormack Street
The Innovation Hub Persequor Pretoria
PO Box 29 The Innovation Hub Pretoria 0087
Tel:+ 27 (0) 12 842 8700
Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME CONCEPT AND VIABILITY

DRAWING TITLE:
MANGAUNG METRO MUNICIPALITY BULK WATER SUPPLY AND SANITATION PROGRAMME

MANGAUNG METRO MUNICIPALITY

ORIGINAL DRAWING SCALE:	NTS	ORIGINAL DRAWING SHEET SIZE:	A1

APPROVED
CLIENT OR ASSIGNEE: DATE:
CLIENT DRAWING No.: CLIENT REF No.:

SURVEYED		DESIGNED	D Sutton
DRAWN	A Steenberg	CHECKED	D Sutton
CO-ORDINATE		DATE.	May 2015

APPROVED ON BEHALF OF BIGEN AFRICA.
ENGINEER: DATE:

DRAWING No.: 2485.00.AAA.01.A012 VERSION A.0

2485.00.AAA.01.A012

Annexure D – Project capital cost estimates

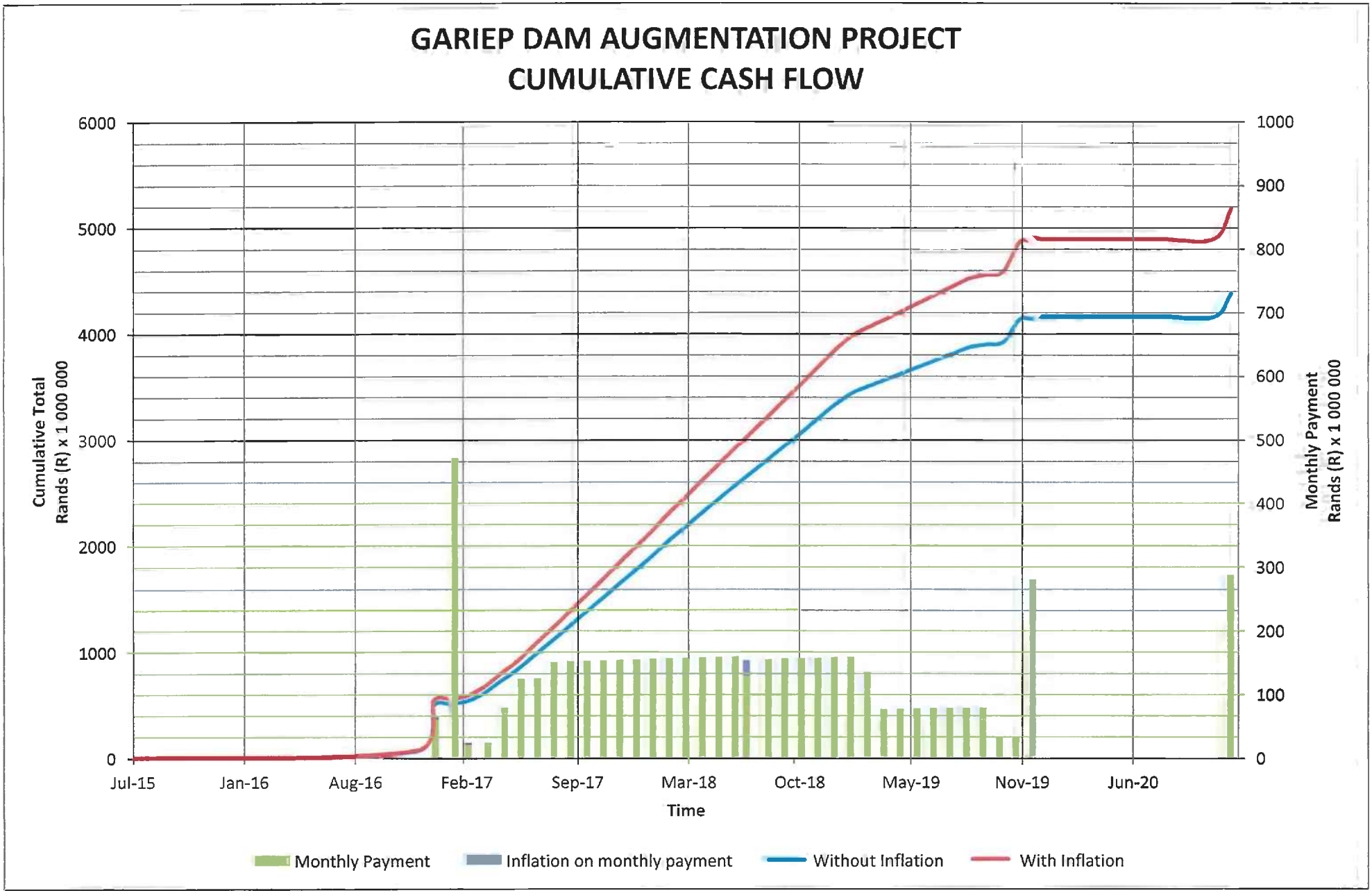
Cost summary (includes P&G's and 10% contingencies)	Pipe diameter			
	1300	**1400**	**1500**	**1600**
Refurbish dam outlet and suction	R 75 000 000	R 75 000 000	R 75 000 000	R 75 000 000
Raw water pump station - civil	R 40 000 000	R 30 000 000	R 30 000 000	R 30 000 000
Raw water pump station - M&E	R 67 843 952	R 61 872 018	R 57 983 316	R 55 413 996
Raw water PV installation	R 0	R 0	R 0	R 0
Raw water pipeline (CH0km to CH12.5km)	R 189 000 000	R 204 000 000	R 221 000 000	R 243 000 000
Water treatment plant - civil	R 432 000 000	R 432 000 000	R 432 000 000	R 432 000 000
Water treatment plant - M&E	R 288 000 000	R 288 000 000	R 288 000 000	R 288 000 000
WTP reservoir 20Ml - 2 hours at peak Q	R 30 000 000	R 30 000 000	R 30 000 000	R 30 000 000
High lift pump station - civil	R 55 000 000	R 55 000 000	R 55 000 000	R 55 000 000
High lift pump station - M&E	R 199 338 760	R 182 611 495	R 171 305 714	R 164 561 915
High lift PV installation	R 0	R 0	R 0	R 0
High lift pipeline (CH12.5km to CH53km)	R 611 000 000	R 662 000 000	R 718 000 000	R 787 000 000
Balancing reservoir 20Ml - 2 hours at peak Q	R 90 000 000	R 90 000 000	R 90 000 000	R 90 000 000
Pipeline (CH53km to CH182km)	R 1 944 000 000	R 2 104 000 000	R 2 283 000 000	R 2 520 000 000
Trompsburg pump station - civil	R 40 000 000	R 40 000 000	R 30 000 000	R 30 000 000
Trompsburg pump station - M&E	R 130 710 690	R 77 487 571	R 42 909 073	R 19 768 587
Trompsburg PV installation	R 0	R 0	R 0	R 0
ESKOM bulk connections	R 42 000 000	R 42 000 000	R 42 000 000	R 42 000 000
Reservoir at Longridge 35Ml - 4 hours at peak Q	R 45 000 000	R 45 000 000	R 45 000 000	R 45 000 000
Total	**R 4 278 893 402**	**R 4 418 971 083**	**R 4 611 198 103**	**R 4 906 744 498**

Gariep to Bloemfontein - Optimisation

Option 2 - RWPS at CH2km, WTP and HLPS at CH12.5km and CH77km

Pump station	Raw water				High lift				Booster			
Pipe diameter	1300	1400	1500	1600	1300	1400	1500	1600	1300	1400	1500	1600
Duty flow (m^3/s)	2.652	2.652	2.652	2.652	2.525	2.525	2.525	2.525	2.525	2.525	2.525	2.525
Duty head (m)	97.7	89.1	83.5	79.8	301.5	276.2	259.1	248.9	197.7	117.2	64.9	29.9
Pump efficiency (%)	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Motor and drive efficiency (%)	0.945	0.945	0.945	0.945	0.945	0.945	0.945	0.945	0.945	0.945	0.945	0.945
Pumping power at duty (kW)	3164.363429	2885.821714	2704.445714	2584.608	9297.516807	8517.327171	7990.005322	7675.462465	6096.580672	3614.159104	2001.356022	922.0422969
Spare motor capacity at duty (%)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Pumping power including margin (kW)	3797.236114	3462.986057	3245.334857	3101.5296	11157.02017	10220.79261	9588.006387	9210.554958	7315.896807	4336.990924	2401.627227	1106.450756
Number of duty pumps	3	3	3	3	3	3	3	3	3	3	3	3
Input power of individual motors (kW)	1265.745371	1154.328686	1081.778286	1033.8432	3719.006723	3406.930868	3196.002129	3070.184986	2438.632269	1445.663641	800.542409	368.8169188
Installed power (kW)	5062.981486	4617.314743	4327.113143	4135.3728	14876.02689	13627.72347	12784.00852	12280.73994	9754.529076	5782.654566	3202.169636	1475.267675
Average flow (m^3/s)	2.066	2.066	2.066	2.066	1.986	1.986	1.986	1.986	1.986	1.986	1.986	1.986
Average head (m)	76	78.3	81.7	87	237.8	244.5	254.6	270	-5.4	16	48.1	97.4
Pumping power at average flow (kW)	1917.618375	1975.651563	2061.439754	2195.168403	5767.789042	5930.296134	6175.269513	6548.793277	-130.9758655	388.0766387	1166.655395	2362.416538
Cost estimates												
M&E cost/MW 13400												
M&E costs	R 67 843 952	R 61 872 018	R 57 983 316	R 55 413 996	R 199 338 760	R 182 611 495	R 171 305 714	R 164 561 915	R 130 710 690	R 77 487 571	R 42 909 073	R 19 768 587
Civil cost	R 40 000 000	R 30 000 000	R 30 000 000	R 30 000 000	R 55 000 000	R 55 000 000	R 55 000 000	R 55 000 000	R 40 000 000	R 40 000 000	R 30 000 000	R 30 000 000
TOTAL	R 107 843 952	R 91 872 018	R 87 983 316	R 85 413 996	R 254 338 760	R 237 611 495	R 226 305 714	R 219 561 915	R 170 710 690	R 117 487 571	R 72 909 073	R 49 768 587

GARIEP DAM AUGMENTATION PROJECT
CUMULATIVE CASH FLOW



Annexure E – Project O&M cost estimates

Operation and Maintenance cost for operational Scenarios 1,2,3 and 4

O&M Costs

	Rated capacity	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
												Unit costs										
Gariep	200					6.55	6.45	6.36	6.28	6.21	6.15	6.10	6.06	6.02	6.00	5.99	5.99	5.99	6.01	6.04	6.08	6.13
Maselspoort (current)		5.80	5.86	5.94	6.06	6.18	6.33	6.48	6.63	6.79	6.96	7.13	7.31	7.49	7.68	7.88	8.08	8.29	8.51	8.73	8.96	9.20
Maselspoort (new)	130	2.09	2.06	2.04	2.06	2.08	2.12	2.16	2.21	2.26	2.31	2.36	2.42	2.48	2.54	2.61	2.68	2.76	2.83	2.92	3.00	3.10
Welbedacht (tariff)	145	5.21	5.34	5.47	5.61	5.75	5.89	6.04	6.19	6.35	6.51	6.67	6.84	7.01	7.18	7.36	7.55	7.73	7.93	8.13	8.33	8.54
Welbedacht (inferred	145	2.58	2.60	2.63	2.65	2.68	2.71	2.75	2.78	2.82	2.87	2.91	2.96	3.01	3.07	3.13	3.19	3.26	3.33	3.41	3.49	3.58
Rustfontein (tariff)	100	5.21	5.34	5.47	5.61	5.75	5.89	6.04	6.19	6.35	6.51	6.67	6.84	7.01	7.18	7.36	7.55	7.73	7.93	8.13	8.33	8.54
Rustfontein (inferred	100	3.37	3.40	3.44	3.48	3.53	3.58	3.63	3.69	3.76	3.83	3.91	3.99	4.08	4.18	4.28	4.39	4.51	4.64	4.77	4.91	5.06

Scenario status quo (required 100 Ml/d expansion to meet average demand)

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035		
Total AADD		249	252	264	275	287	299	305	311	317	324	330	337	343	350	357	364	372	379	387	394	402		
Gariep	AADD																						R/m3	
	Fixed cost																						-	
	Variable cost																							
	Total cost																							
Maselspoort (current	AADD	70	70	70	70	70	70	70	80	80	80	90	100	100	110	110	110	110	110	110	110	110	R/m3	
	Fixed cost	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	319 200 000	7.52
	Variable cos	133 018 098	136 433 095	139 955 127	143 587 952	147 335 478	151 201 765	155 191 038	182 065 927	186 921 458	191 933 209	221 745 179	253 060 231	259 954 249	293 780 894	301 869 018	310 223 527	318 854 288	327 771 579	336 986 098	346 508 994	356 351 874	4 894 749 079	
	Total cost	148 218 098	151 633 095	155 155 127	158 787 952	162 535 478	166 401 766	170 391 038	197 265 927	202 121 458	207 133 209	236 945 179	268 260 231	275 154 249	308 980 894	317 069 018	325 423 527	334 054 288	342 971 579	352 186 098	361 708 994	371 551 874	5 213 949 079	
Welbedacht	AADD	79	82	94	105	117	129	135	131	137	144	140	137	143	140	140	140	140	140	140	140	140	R/m3	
	Fixed cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.86
	Variable co	151 097 389	160 260 478	186 909 906	215 253 325	245 379 817	277 382 818	297 493 618	296 099 501	317 899 201	340 896 219	340 807 346	340 820 521	366 530 488	367 447 715	376 177 433	385 581 869	395 221 416	405 101 951	415 229 500	425 610 238	436 250 494	6 743 451 242	
	Total cost	151 097 389	160 260 478	186 909 906	215 253 325	245 379 817	277 382 818	297 493 618	296 099 501	317 899 201	340 896 219	340 807 346	340 820 521	366 530 488	367 447 715	376 177 433	385 581 869	395 221 416	405 101 951	415 229 500	425 610 238	436 250 494	6 743 451 242	
Rustfontein	AADD	100	100	100	100	100	100	100	100	100	100	100	100	100	100	107	114	122	129	137	144	152	R/m3	
	Fixed cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.87
	Variable cos	190 165 000	194 919 125	199 792 103	204 786 906	209 906 578	215 154 243	220 533 099	226 046 426	231 697 587	237 490 027	243 427 277	249 512 959	255 750 783	262 144 553	287 937 358	314 769 741	343 162 778	373 195 849	404 952 154	438 518 883	473 987 414	5 777 850 843	
	Total cost	190 165 000	194 919 125	199 792 103	204 786 906	209 906 578	215 154 243	220 533 099	226 046 426	231 697 587	237 490 027	243 427 277	249 512 959	255 750 783	262 144 553	287 937 358	314 769 741	343 162 778	373 195 849	404 952 154	438 518 883	473 987 414	5 777 850 843	
Total Annual system cost		489 480 487	506 812 698	541 857 136	578 828 183	617 821 874	658 938 826	688 417 755	719 411 854	751 718 245	785 519 455	821 179 803	858 593 711	897 435 521	938 573 161	981 183 809	1 025 775 137	1 072 438 482	1 121 269 379	1 172 367 752	1 225 838 115	1 281 789 782	17 735 251 164	7.04
Total O&M life cycle cost		17 735 251 164																						

Scenario 1 (50% split between Welbedacht and Maselspoort, Gariep shortage)

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035		
Total AADD		249	252	264	275	287	299	305	311	317	324	330	337	343	350	357	364	372	379	387	394	402		
Gariep	AADD						4	6	8	11	13	16	18	21	23	26	29	32	34	40	45	51	R/m3	
	Fixed cost						51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	817 200 000	9.10
	Variable cost						3 122 658	5 113 220	7 274 081	9 619 724	12 165 799	14 929 212	17 928 222	21 182 542	24 713 455	28 543 931	32 698 759	37 204 681	42 090 545	50 251 385	59 986 039	70 594 824	437 419 076	
	Total cost						54 197 658	56 188 220	58 349 081	60 694 724	63 240 799	66 004 212	69 003 222	72 257 542	75 788 455	79 618 931	83 773 759	88 279 681	93 165 545	101 326 385	111 061 039	121 669 824	1 254 619 076	
Maselspoort (current	AADD	96	96	100	105	109	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	R/m3	
	Fixed cost	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	319 200 000	2.43
	Variable cos	52 345 530	53 754 663	57 686 345	61 875 367	66 340 708	68 674 527	70 642 779	72 709 442	74 879 440	77 157 937	79 550 358	82 062 401	84 700 046	87 469 574	90 377 577	93 430 981	96 637 055	100 003 433	103 538 130	107 249 561	111 146 564	1 692 232 420	
	Total cost	67 545 530	68 954 663	72 886 345	77 075 367	81 540 708	83 874 527	85 842 779	87 909 442	90 079 440	92 357 937	94 750 358	97 262 401	99 900 046	102 669 574	105 577 577	108 630 981	111 837 055	115 203 433	118 738 130	122 449 561	126 346 564	2 011 432 420	
Welbedacht	AADD	96	96	100	105	109	114	116	118	121	123	126	128	131	133	136	139	142	144	145	145	145	R/m3	
	Fixed cost	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	684 586 875	3.00
	Variable co	58 969 259	60 406 930	64 664 830	69 189 253	73 999 568	79 116 586	82 807 524	86 721 600	90 873 867	95 280 432	99 958 526	104 926 585	110 204 338	115 812 892	121 774 834	128 114 336	134 857 263	142 031 296	147 377 809	152 343 905	157 558 305	2 176 989 934	
	Total cost	91 568 634	93 006 305	97 264 205	101 788 628	106 598 943	111 715 961	115 406 899	119 320 975	123 473 242	127 879 807	132 557 901	137 525 960	142 803 713	148 412 267	154 374 209	160 713 711	167 456 638	174 630 671	179 977 184	184 943 280	190 157 680	2 861 576 809	
Rustfontein	AADD	58	61	63	66	68	71	73	74	75	77	79	80	82	83	85	87	88	90	92	94	96	R/m3	
	Fixed cost	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	545 212 500	4.10
	Variable cos	45 438 144	48 910 646	52 627 865	56 608 199	60 871 428	65 438 814	69 036 090	72 867 794	76 950 153	81 300 534	85 937 531	90 881 047	96 152 392	101 774 379	107 771 430	114 169 693	120 997 162	128 283 810	136 061 727	144 365 272	153 231 231	1 909 675 340	
	Total cost	71 400 644	74 873 146	78 590 365	82 570 699	86 833 928	91 401 314	94 998 590	98 830 294	102 912 653	107 263 034	111 900 031	116 843 547	122 114 892	127 736 879	133 733 930	140 132 193	146 959 662	154 246 310	162 024 227	170 327 772	179 193 731	2 454 887 840	
Total Annual system cost		230 514 807	236 834 114	248 740 914	261 434 694	274 973 579	341 189 459	352 436 487	364 409 792	377 160 058	390 741 577	405 212 502	420 635 131	437 076 193	454 607 174	473 304 647	493 250 643	514 533 036	537 245 959	562 065 926	588 781 652	617 367 800	8 582 516 145	3.41
Total O&M life cycle cost		8 582 516 145																						

Scenario 1b (with current Bloem Water tariff)

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035		
Total AADD		249	252	264	275	287	299	305	311	317	324	330	337	343	350	357	364	372	379	387	394	402		
Gariep	AADD						4	6	8	11	13	16	18	21	23	26	29	32	34	40	45	51	R/m3	
	Fixed cost						51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	817 200 000	9.10
	Variable cost						3 122 658	5 113 220	7 274 081	9 619 724	12 165 799	14 929 212	17 928 222	21 182 542	24 713 455	28 543 931	32 698 759	37 204 681	42 090 545	50 251 385	59 986 039	70 594 824	437 419 076	
	Total cost						54 197 658	56 188 220	58 349 081	60 694 724	63 240 799	66 004 212	69 003 222	72 257 542	75 788 455	79 618 931	83 773 759	88 279 681	93 165 545	101 326 385	111 061 039	121 669 824	1 254 619 076	
Maselspoort (current	AADD	96	96	100	105	109	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	R/m3	
	Fixed cost	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	319 200 000	2.43
	Variable cos	52 345 530	53 754 663	57 686 345	61 875 367	66 340 708	68 674 527	70 642 779	72 709 442	74 879 440	77 157 937	79 550 358	82 062 401	84 700 046	87 469 574	90 377 577	93 430 981	96 637 055	100 003 433	103 538 130	107 249 561	111 146 564	1 692 232 420	
	Total cost	67 545 530	68 954 663	72 886 345	77 075 367	81 540 708	83 874 527	85 842 779	87 909 442	90 079 440	92 357 937	94 750 358	97 262 401	99 900 046	102 669 574	105 577 577	108 630 981	111 837 055	115 203 433	118 738 130	122 449 561	126 346 564	2 011 432 420	
Welbedacht	AADD	96	96	100	105	109	114	116	118	121	123	126	128	131	133	136	139	142	144	145	145	145	R/m3	
	Fixed cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.87
	Variable co	182 031 008	186 815 054	200 235 422	214 388 175	229 309 665	245 037 975	256 183 081	267 833 905	280 013 377	292 745 468	306 055 234	319 968 869	334 513 754	349 718 511	365 613 061	382 228 681	399 598 068	417 755 399	430 059 125	440 810 603	451 830 868	6 552 745 307	
	Total cost	182 031 008	186 815 054	200 235 422	214 388 175	229 309 665	245 037 975	256 183 081	267 833 905	280 013 377	292 745 468	306 055 234	319 968 869	334 513 754	349 718 511	365 613 061	382 228 681	399 598 068	417 755 399	430 059 125	440 810 603	451 830 868	6 552 745 307	
Rustfontein	AADD	58	61	63	66	68	71	73	74	75	77	79	80	82	83	85	87	88	90	92	94	96	R/m3	
	Fixed cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.88
	Variable cos	110 315 872	117 992 882	126 085 637	134 614 715	143 601 670	153 069 081	160 033 724	167 315 258	174 928 102	182 887 331	191 208 705	199 908 701	209 004 547	218 514 254	228 456 652	238 851 430	249 719 170	261 081 392	272 960 595	285 380 302	298 365 106	4 124 295 126	
	Total cost	110 315 872	117 992 882	126 085 637	134 614 715	143 601 670	153 069 081	160 033 724	167 315 258	174 928 102	182 887 331	191 208 705	199 908 701	209 004 547	218 514 254	228 456 652	238 851 430	249 719 170	261 081 392	272 960 595	285 380 302	298 365 106	4 124 295 126	
Total Annual system cost		359 892 411	373 762 599	399 207 404	426 078 257	454 452 043	536 179 240	558 247 804	581 407 687	605 715 643	631 231 535	658 018 510	686 143 193	715 675 889	746 690 793	779 266 222	813 484 851	849 433 974	887 205 769	923 084 235	959 701 506	998 212 363	13 943 091 928	5.54
Total O&M life cycle cost		13 943 091 928																						

Scenario 2
(33% split between Gariep, Welbedacht and Maselspoort)

Total AADD		249	252	264	275	287	299	305	311	317	324	330	337	343	350	357	364	372	379	387	394	402	
Gariep	AADD					73	76	77	79	81	82	84	85	87	89	91	93	94	96	98	100	102	R/m3
	Fixed cost					51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	868 275 000	4.50
	Variable cost					56 633 663	60 957 739	64 227 506	67 707 941	71 413 557	75 359 888	79 563 558	84 042 362	88 815 346	93 902 897	99 326 838	105 110 527	111 278 969	117 858 931	124 879 065	132 370 045	140 364 707	1 573 813 539	
	Total cost					107 708 663	112 032 739	115 302 506	118 782 941	122 488 557	126 434 888	130 638 558	135 117 362	139 890 346	144 977 897	150 401 838	156 185 527	162 353 969	168 933 931	175 954 065	183 445 045	191 439 707	2 442 088 539	
Maselspoort (current	AADD	96	110	110	110	73	76	77	79	81	82	84	85	87	89	91	93	94	96	98	100	102	R/m3	
	Fixed cost	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	319 200 000	2.50
	Variable cos	52 345 530	61 695 205	63 314 491	65 014 740	44 227 139	47 401 842	49 734 813	52 212 535	54 844 857	57 642 322	60 616 208	63 778 587	67 142 377	70 721 400	74 530 451	78 585 364	82 903 085	87 501 750	92 400 772	97 620 930	103 184 464	1 427 418 861	
	Total cost	67 545 530	76 895 205	78 514 491	80 214 740	59 427 139	62 601 842	64 934 813	67 412 535	70 044 857	72 842 322	75 816 208	78 978 587	82 342 377	85 921 400	89 730 451	93 785 364	98 103 085	102 701 750	107 600 772	112 820 930	118 384 464	1 746 618 861	
Welbedacht	AADD	96	96	100	105	73	76	77	79	81	82	84	85	87	89	91	93	94	96	98	100	102	R/m3	
	Fixed cost	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	684 586 875	3.24
	Variable cos	58 969 259	60 406 930	64 664 830	69 189 253	49 333 045	52 744 391	55 205 016	57 814 400	60 582 578	63 520 288	66 639 017	69 951 057	73 469 559	77 208 594	81 183 223	85 409 557	89 904 842	94 687 531	99 777 373	105 195 505	110 964 549	1 546 820 793	
	Total cost	91 568 634	93 006 305	97 264 205	101 788 628	81 932 420	85 343 766	87 804 391	90 413 775	93 181 953	96 119 663	99 238 392	102 550 432	106 068 934	109 807 969	113 782 598	118 008 932	122 504 217	127 286 906	132 376 748	137 794 880	143 563 924	2 231 407 668	
Rustfontein	AADD	58	61	63	66	68	71	73	74	75	77	79	80	82	83	85	87	88	90	92	94	96	R/m3	
	Fixed cost	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	545 212 500	4.10
	Variable cos	45 438 144	48 910 646	52 627 865	56 608 199	60 871 428	65 438 814	69 036 090	72 867 794	76 950 153	81 300 534	85 937 531	90 881 047	96 152 392	101 774 379	107 771 430	114 169 693	120 997 162	128 283 810	136 061 727	144 365 272	153 231 231	1 909 675 340	
	Total cost	71 400 644	74 873 146	78 590 365	82 570 699	86 833 928	91 401 314	94 998 590	98 830 294	102 912 653	107 263 034	111 900 031	116 843 547	122 114 892	127 736 879	133 733 930	140 132 193	146 959 662	154 246 310	162 024 227	170 327 772	179 193 731	2 454 887 840	
Total Annual system cost		230 514 807	244 774 656	254 369 060	264 574 067	335 902 150	351 379 660	363 040 300	375 439 545	388 628 021	402 659 907	417 593 189	433 489 928	450 416 548	468 444 145	487 648 816	508 112 016	529 920 932	553 168 896	577 955 812	604 388 627	632 581 825	8 875 002 908	3.53
Total O&M life cycle cost		8 875 002 908																					

Scenario 2b
(With current Bloem Water tariff)

Total AADD		249	252	264	275	287	299	305	311	317	324	330	337	343	350	357	364	372	379	387	394	402	
Gariep	AADD					73	76	77	79	81	82	84	85	87	89	91	93	94	96	98	100	102	R/m3
	Fixed cost					51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	868 275 000	4.50
	Variable cost					56 633 663	60 957 739	64 227 506	67 707 941	71 413 557	75 359 888	79 563 558	84 042 362	88 815 346	93 902 897	99 326 838	105 110 527	111 278 969	117 858 931	124 879 065	132 370 045	140 364 707	1 573 813 539	
	Total cost					107 708 663	112 032 739	115 302 506	118 782 941	122 488 557	126 434 888	130 638 558	135 117 362	139 890 346	144 977 897	150 401 838	156 185 527	162 353 969	168 933 931	175 954 065	183 445 045	191 439 707	2 442 088 539	
Maselspoort (current	AADD	96	110	110	110	73	76	77	79	81	82	84	85	87	89	91	93	94	96	98	100	102	R/m3	
	Fixed cost	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	319 200 000	2.50
	Variable cos	52 345 530	61 695 205	63 314 491	65 014 740	44 227 139	47 401 842	49 734 813	52 212 535	54 844 857	57 642 322	60 616 208	63 778 587	67 142 377	70 721 400	74 530 451	78 585 364	82 903 085	87 501 750	92 400 772	97 620 930	103 184 464	1 427 418 861	
	Total cost	67 545 530	76 895 205	78 514 491	80 214 740	59 427 139	62 601 842	64 934 813	67 412 535	70 044 857	72 842 322	75 816 208	78 978 587	82 342 377	85 921 400	89 730 451	93 785 364	98 103 085	102 701 750	107 600 772	112 820 930	118 384 464	1 746 618 861	
Welbedacht	AADD	96	96	100	105	73	76	77	79	81	82	84	85	87	89	91	93	94	96	98	100	102	R/m3	
	Fixed cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.78
	Variable cos	182 031 008	186 815 054	200 235 422	214 388 175	152 873 110	163 358 650	170 788 721	178 555 937	186 675 585	195 163 645	204 036 823	213 312 580	223 009 169	233 145 674	243 742 041	254 819 121	266 398 712	278 503 600	291 157 603	304 385 621	318 213 682	4 661 609 932	
	Total cost	182 031 008	186 815 054	200 235 422	214 388 175	152 873 110	163 358 650	170 788 721	178 555 937	186 675 585	195 163 645	204 036 823	213 312 580	223 009 169	233 145 674	243 742 041	254 819 121	266 398 712	278 503 600	291 157 603	304 385 621	318 213 682	4 661 609 932	
Rustfontein	AADD	58	61	63	66	68	71	73	74	75	77	79	80	82	83	85	87	88	90	92	94	96	R/m3	
	Fixed cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.88
	Variable cos	110 315 872	117 992 882	126 085 637	134 614 715	143 601 670	153 069 081	160 033 724	167 315 258	174 928 102	182 887 331	191 208 705	199 908 701	209 004 547	218 514 254	228 456 652	238 851 430	249 719 170	261 081 392	272 960 595	285 380 302	298 365 106	4 124 295 126	
	Total cost	110 315 872	117 992 882	126 085 637	134 614 715	143 601 670	153 069 081	160 033 724	167 315 258	174 928 102	182 887 331	191 208 705	199 908 701	209 004 547	218 514 254	228 456 652	238 851 430	249 719 170	261 081 392	272 960 595	285 380 302	298 365 106	4 124 295 126	
Total Annual system cost		359 892 411	381 703 142	404 835 550	429 217 630	463 610 582	491 062 311	511 059 764	532 066 671	554 137 102	577 328 186	601 700 294	627 317 229	654 246 438	682 559 224	712 330 982	743 641 442	776 574 935	811 220 672	847 673 036	886 031 899	926 402 959	12 974 612 458	5.15
Total O&M life cycle cost		12 974 612 458																					

Scenario 3
(50% Gariep and Maselspoort)

Total AADD		249	252	264	275	287	299	305	311	317	324	330	337	343	350	357	364	372	379	387	394	402	
Gariep	AADD					103	112	116	121	126	130	135	140	145	150	155	161	166	171	177	183	189	R/m3
	Fixed cost					51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	868 275 000	3.90
	Variable cost					79 795 168	89 858 156	96 504 222	103 621 554	111 245 434	119 413 780	128 167 337	137 549 884	147 608 462	158 393 608	169 959 619	182 364 820	195 671 867	209 948 060	225 265 687	241 702 384	259 341 535	2 656 411 577	
	Total cost					130 870 168	140 933 156	147 579 222	154 696 554	162 320 434	170 488 780	179 242 337	188 624 884	198 683 462	209 468 608	221 034 619	233 439 820	246 746 867	261 023 060	276 340 687	292 777 384	310 416 535	3 524 686 577	
Maselspoort (current	AADD	96	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	R/m3	
	Fixed cost	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	319 200 000	2.42
	Variable cos	52 345 530.09	61 695 205.28	63 314 490.55	65 014 740.08	66 800 002.08	68 674 527.18	70 642 778.54	72 709 442.47	74 879 439.59	77 157 936.57	79 550 358.40	82 062 401.32	84 700 046.39	87 469 573.71	90 377 577.39	93 430 981.26	96 637 055.33	100 003 433.09	103 538 129.75	107 249 561.23	111 146 564.30	1 709 399 775	
	Total cost	67 545 530	76 895 205	78 514 491	80 214 740	82 000 002	83 874 527	85 842 779	87 909 442	90 079 440	92 357 937	94 750 358	97 262 401	99 900 046	102 669 574	105 577 577	108 630 981	111 837 055	115 203 433	118 738 130	122 449 561	126 346 564	2 028 599 775	
Welbedacht	AADD	96	82	90	99	5.87	5.86	5.97	6.08	6.20	6.32	6.43	6.55	6.67	6.79	6.92	7.04	7.17	7.29	7.42	7.55	7.68	R/m3	
	Fixed cost	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	684 586 875	5.80
	Variable cos	58 969 259	51 483 727	58 355 831	65 678 795	3 978 439	4 067 690	4 254 859	4 452 500	4 661 280	4 881 908	5 115 138	5 361 776	5 622 675	5 898 745	6 190 954	6 500 332	6 827 974	7 175 044	7 542 784	7 932 511	8 345 629	333 297 850	
	Total cost	91 568 634	84 083 102	90 955 206	98 278 170	36 577 814	36 667 065	36 854 234	37 051 875	37 260 655	37 481 283	37 714 513	37 961 151	38 222 050	38 498 120	38 790 329	39 099 707	39 427 349	39 774 419	40 142 159	40 531 886	40 945 004	1 017 884 725	
Rustfontein	AADD	58	61	63	66	68	71	73	74	75	77	79	80	82	83	85	87	88	90	92	94	96	R/m3	
	Fixed cost	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	545 212 500	4.10
	Variable cos	45 438 144	48 910 646	52 627 865	56 608 199	60 871 428	65 438 814	69 036 090	72 867 794	76 950 153	81 300 534	85 937 531	90 881 047	96 152 392	101 774 379	107 771 430	114 169 693	120 997 162	128 283 810	136 061 727	144 365 272	153 231 231	1 909 675 340	
	Total cost	71 400 644	74 873 146	78 590 365	82 570 699	86 833 928	91 401 314	94 998 590	98 830 294	102 912 653	107 263 034	111 900 031	116 843 547	122 114 892	127 736 879	133 733 930	140 132 193	146 959 662	154 246 310	162 024 227	170 327 772	179 193 731	2 454 887 840	
Total Annual system cost		230 514 807	235 851 453	248 060 061	261 063 609	336 281 911	352 876 062	365 274 825	378 488 166	392 573 182	407 591 034	423 607 240	440 691 984	458 920 451	478 373 181	499 136 455	521 302 701	544 970 933	570 247 223	597 245 202	626 086 604	656 901 834	9 026 058 917	3.59
Total O&M life cycle cost		9 026 058 917																					

Scenario 3b
(with current Bloem Water tariff)

Total AADD		249	252	264	275	287	299	305	311	317	324	330	337	343	350	357	364	372	379	387	394	402	
Gariep	AADD					103	112	116	121	126	130	135	140	145	150	155	161	166	171	177	183	189	R/m3
	Fixed cost					51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	868 275 000	3.90
	Variable cost					79 795 168	89 858 156	96 504 222	103 621 554	111 245 434	119 413 780	128 167 337	137 549 884	147 608 462	158 393 608	169 959 619	182 364 820	195 671 867	209 948 060	225 265 687	241 702 384	259 341 535	2 656 411 577	
	Total cost					130 870 168	140 933 156	147 579 222	154 696 554	162 320 434	170 488 780	179 242 337	188 624 884	198 683 462	209 468 608	221 034 619	233 439 820	246 746 867	261 023 060	276 340 687	292 777 384	310 416 535	3 524 686 577	
Maselspoort (current	AADD	96	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	R/m3	
	Fixed cost	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	15 200 000	319 200 000	2.42
	Variable cos	52 345 530.09	61 695 205.28	63 314 490.55	65 014 740.08	66 800 002.08	68 674 527.18	70 642 778.54	72 709 442.47	74 879 439.59	77 157 936.57	79 550 358.40	82 062 401.32	84 700 046.39	87 469 573.71	90 377 577.39	93 430 981.26	96 637 055.33	100 003 433.09	103 538 129.75	107 249 561.23	111 146 564.30	1 709 399 775	
	Total cost	67 545 530	76 895 205	78 514 491	80 214 740	82 000 002	83 874 527	85 842 779	87 909 442	90 079 440	92 357 937	94 750 358	97 262 401	99 900 046	102 669 574	105 577 577	108 630 981	111 837 055	115 203 433	118 738 130	122 449 561	126 346 564	2 028 599 775	
Welbedacht	AADD	96	82	90	99	5.87	5.86	5.97	6.08	6.20	6.32	6.43	6.55	6.67	6.79	6.92	7.04	7.17	7.29	7.42	7.55	7.68	R/m3	
	Fixed cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.21
	Variable cos	182 031 008	155 335 679	171 992 414	188 979 966	11 168 899	11 135 107	11 350 701	11 568 450	11 788 378	12 010 504	12 234 852	12 461 443	12 690 300	12 921 446	13 154 903	13 390 695	13 628 844	13 869 375	14 112 312	14 357 678	14 605 497	914 788 451	
	Total cost	182 031 008	155 335 679	171 992 414	188 979 966	11 168 899	11 135 107	11 350 701	11 568 450	11 788 378	12 010 504	12 234 852	12 461 443	12 690 300	12 921 446	13 154 903	13 390 695	13 628 844	13 869 375	14 112 312	14 357 678	14 605 497	914 788 451	
Rustfontein	AADD	58	61	63	66	68	71	73	74	75	77	79	80	82	83	85	87	88	90	92	94	96	R/m3	
	Fixed cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.88
	Variable cos	110 315 872	117 992 882	126 085 637	134 614 715	143 601 670	153 069 081	160 033 724	167 315 258	174 928 102	182 887 331	191 208 705	199 908 701	209 004 547	218 514 254	228 456 652	238 851 430	249 719 170	261 081 392	272 960 595	285 380 302	298 365 106	4 124 295 126	
	Total cost	110 315 872	117 992 882	126 085 637	134 614 715	143 601 670	153 069 081	160 033 724	167 315 258	174 928 102	182 887 331	191 208 705	199 908 701	209 004 547	218 514 254	228 456 652	238 851 430	249 719 170	261 081 392	272 960 595	285 380 302	298 365 106	4 124 295 126	
Total Annual system cost		359 892 411	350 223 766	376 592 542	403 809 421	367 640 738	389 011 871	404 806 425	421 489 705	439 116 354	457 744 552	477 436 252	498 257 429	520 278 355	543 573 881	568 223 751	594 312 925	621 931 936	651 177 261	682 151 724	714 964 926	749 733 703	10 592 369 928	4.21
Total O&M life cycle cost		10 592 369 928																					

Scenario 4 (requires GBWSS to be sized 300 Ml/d)	Total AADD		249	252	264	275	287	299	305	311	317	324	330	337	343	350	357	364	372	379	387	394	402		
	Garlep	AADD					213	222	226	231	236	240	245	250	255	260	265	271	276	281	287	293	299		R/m3
		Fixed cost					51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	51 075 000	868 275 000	3.45
		Variable cost					165 333 797	178 172 107	187 732 261	197 909 385	208 746 046	220 287 813	232 583 461	245 685 205	259 648 938	274 534 499	290 405 944	307 331 851	325 385 640	344 645 912	365 196 821	387 128 465	410 537 310	4 601 265 455	
		Total cost					216 408 797	229 247 107	238 807 261	248 984 385	259 821 046	271 362 813	283 658 461	296 760 205	310 723 938	325 609 499	341 480 944	358 406 851	376 460 640	395 720 912	416 271 821	438 203 465	461 612 310	5 469 540 455	
	Maselspoort (current	AADD	96	110	110	110												-		-	-				R/m3
		Fixed cost	15 200 000	15 200 000	15 200 000	15 200 000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60 800 000	1.95
		Variable cos	52 345 530.09	61 695 205.28	63 314 490.55	65 014 740.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	242 369 966	
		Total cost	67 545 530	76 895 205	78 514 491	80 214 740	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	303 169 966	
	Welbedacht	AADD	96	96	100	105	5.87	5.86	5.97	6.08	6.20	6.32	6 43	6.55	6 67	6.79	6.92	7.04	7.17	7.29	7.42	7.55	7.68		R/m3
		Fixed cost	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	32 599 375	684 586 875	5.57
		Variable co	58 969 259	60 406 930	64 664 830	69 189 253	3 978 439	4 067 690	4 254 859	4 452 500	4 661 280	4 881 908	5 115 138	5 361 776	5 622 675	5 898 745	6 190 954	6 500 332	6 827 974	7 175 044	7 542 784	7 932 511	8 345 629	352 040 510	
		Total cost	91 568 634	93 006 305	97 264 205	101 788 628	36 577 814	36 667 065	36 854 234	37 051 875	37 260 655	37 481 283	37 714 513	37 961 151	38 222 050	38 498 120	38 790 329	39 099 707	39 427 349	39 774 419	40 142 159	40 531 886	40 945 004	1 036 627 385	
	Rustfontein	AADD	58	61	63	66	68	71	73	74	75	77	79	80	82	83	85	87	88	90	92	94	96		R/m3
		Fixed cost	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	25 962 500	545 212 500	4.10
		Variable cos	45 438 144	48 910 646	52 627 865	56 608 199	60 871 428	65 438 814	69 036 090	72 867 794	76 950 153	81 300 534	85 937 531	90 881 047	96 152 392	101 774 379	107 771 430	114 169 693	120 997 162	128 283 810	136 061 727	144 365 272	153 231 231	1 909 675 340	
		Total cost	71 400 644	74 873 146	78 590 365	82 570 699	86 833 928	91 401 314	94 998 590	98 830 294	102 912 653	107 263 034	111 900 031	116 843 547	122 114 892	127 736 879	133 733 930	140 132 193	146 959 662	154 246 310	162 024 227	170 327 772	179 193 731	2 454 887 840	
	Total Annual system cost		230 514 807	244 774 656	254 369 060	264 574 067	339 820 539	357 315 486	370 660 085	384 866 554	399 994 355	416 107 130	433 273 006	451 564 903	471 060 881	491 844 498	514 005 203	537 638 751	562 847 650	589 741 641	618 438 207	649 063 123	681 751 045	9 264 225 647	3.68
	Total O&M life cycle cost		9 264 225 647																						

Disregard Scenario 4 due to size of system required

			Relative annual O&M saving																				
	Total O&M life cycle cost	Total O&M life cycle saving	2 015	2 016	2 017	2 018	2 019	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027	2 028	2 029	2 030	2 031	2 032	2 033	2 034	2 035
	17 735 251 164	-	489 480 487	506 812 698	541 857 136	578 828 183	617 821 874	658 938 826	688 417 755	719 411 854	751 718 245	785 519 455	821 179 803	858 593 711	897 435 521	938 573 161	981 183 809	1 025 775 137	1 072 438 482	1 121 269 379	1 172 367 752	1 225 838 115	1 281 789 782
	8 582 516 145	9 152 735 019	258 965 680	269 978 584	293 116 222	317 393 489	342 848 295	317 749 367	335 981 267	355 002 061	374 558 187	394 777 878	415 967 301	437 958 581	460 359 327	483 965 987	507 879 162	532 524 493	557 905 446	584 023 421	610 301 826	637 056 463	664 421 982
	8 875 002 908	8 860 248 256	258 965 680	262 038 042	287 488 076	314 254 117	281 919 723	307 559 166	325 377 455	343 972 309	363 090 225	382 859 548	403 586 614	425 103 783	447 018 972	470 129 016	493 534 993	517 663 121	542 517 550	568 100 483	594 411 940	621 449 487	649 207 956
	10 592 369 928	8 709 192 247	258 965 680	270 961 245	293 797 075	317 764 574	281 539 963	306 062 764	323 142 930	340 923 688	359 145 064	377 928 421	397 572 563	417 901 728	438 515 070	460 199 980	482 047 354	504 472 436	527 467 549	551 022 157	575 122 550	599 751 511	624 887 947

			Relative annual O&M saving																				
	Total O&M life cycle cost	Total O&M life cycle saving						-	-						-			-					-
	17 735 251 164	-	489 480 487	506 812 698	541 857 136	578 828 183	617 821 874	658 938 826	688 417 755	719 411 854	751 718 245	785 519 455	821 179 803	858 593 711	897 435 521	938 573 161	981 183 809	1 025 775 137	1 072 438 482	1 121 269 379	1 172 367 752	1 225 838 115	1 281 789 782
	13 943 091 928	3 792 159 236	129 588 076	133 050 099	142 649 732	152 749 926	163 369 831	122 759 586	130 169 951	138 004 167	146 002 602	154 287 920	163 161 293	172 450 518	181 759 632	191 882 368	201 917 587	212 290 285	223 004 508	234 063 610	249 283 517	266 136 608	283 577 418
	12 974 612 458	4 760 638 707	129 588 076	125 109 556	137 021 586	149 610 553	154 211 292	167 876 515	177 357 991	187 345 183	197 581 144	208 191 268	219 479 509	231 276 482	243 189 082	256 013 937	268 852 828	282 133 695	295 863 547	310 048 707	324 694 716	339 806 216	355 386 823
	10 592 369 928	7 142 881 236	129 588 076	156 588 932	165 264 594	175 018 762	250 181 135	269 926 955	283 611 329	297 922 149	312 601 892	327 774 902	343 743 551	360 336 282	377 157 166	394 999 280	412 960 058	431 462 211	450 506 546	470 092 119	490 216 029	510 873 189	532 056 079

Operation and maintenance cost for different water supply systems

Garieb system

Operating cost element			Water use effciency factor	Above inflation factor	Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
					Annual operating cost																					
System capacity										100	104	108	112	117	122	127	132	137	142	148	154	160	167	173	180	187
Raw water																										
Gariep dam	0.2	R/m3	1.05	1						7 665 000	7 971 600	8 290 464	8 622 083	8 966 966	9 325 644	9 698 670	10 086 617	10 490 082	10 909 685	11 346 072	11 799 915	12 271 912	12 762 788	13 273 300	13 804 232	14 356 401
Energy																										
Raw water PS	82	m	1.05							8 012 432	8 332 929	8 666 246	9 012 896	9 373 412	9 748 348	10 138 282	10 543 813	10 965 566	11 404 189	11 860 356	12 334 770	12 828 161	13 341 288	13 874 939	14 429 937	15 007 134
High lift PS	268	m	1							24 939 973	25 937 572	26 975 075	28 054 078	29 176 241	30 343 291	31 557 022	32 819 303	34 132 075	35 497 358	36 917 253	38 393 943	39 929 701	41 526 889	43 187 964	44 915 483	46 712 102
Booster PS	92	m	1							8 561 483	8 903 943	9 260 100	9 630 504	10 015 725	10 416 354	10 833 008	11 266 328	11 716 981	12 185 660	12 673 087	13 180 010	13 707 211	14 255 499	14 825 719	15 418 748	16 035 498
Total	0 75	R/kWh		1.05						50 460 391	55 102 747	60 172 199	65 708 042	71 753 181	78 354 474	85 563 086	93 434 890	102 030 899	111 417 742	121 668 174	132 861 647	145 084 918	158 432 730	173 008 542	188 925 328	206 306 458
Treatment	mg/l	R/kg																								
Lime	60	2 8		1																						
Poly	10	15		1						0.19																
Chlorine	10	22		1																						
Total										19 637 000	20 422 480	21 239 379	22 088 954	22 972 513	23 891 413	24 847 070	25 840 952	26 874 590	27 949 574	29 067 557	30 230 259	31 439 470	32 697 048	34 004 930	35 365 128	36 779 733
Maintenance & Transport	Capital split	% maintenance																								
	70%	0.50%		1						15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000	15 050 000
Total CAPEX	15%	1%		1						3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000	3 225 000
	15%	4%		1						25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000	25 800 000
	4 300 000 000									44 075 000	44 075 000	44 075 000	44 075 000	44 075 000	44 075 000	44 075 000	44 075 000	44 075 000	44 075 000	44 075 000	44 075 000	44 075 000	44 075 000	44 075 000	44 075 000	44 075 000
Grant funding	3 200 000 000																									
Salaries	7 000 000									7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000
Total O&M cost				1						128 837 391	134 571 827	140 777 042	147 494 079	154 767 660	162 646 532	171 183 826	180 437 459	190 470 572	201 352 001	213 156 804	225 966 821	239 871 300	254 967 567	271 361 772	289 169 687	308 517 592
Unit variable cost		R/kl								2.13	2.20	2.27	2 35	2 43	2.51	2.60	2 69	2 79	2 89	3.00	3.11	3.23	3.35	3.49	3.62	3.77
Unit O&M cost		R/kl								3.53	3.55	3.57	3 59	3.62	3.66	3.71	3 76	3.81	3.88	3.95	4.02	4.10	4.20	4.29	4.40	4.51
Finance cost	Int rate	8%								110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089	110 410 089
Total O&M and finance cost		1								239 247 480	244 981 916	251 187 132	257 904 168	265 177 749	273 056 621	281 593 915	290 847 548	300 880 661	311 762 090	323 566 893	336 376 910	350 281 389	365 377 656	381 771 861	399 579 776	418 927 681
Unit rate		R/kl								6.55	6.45	6 36	6.28	6.21	6.15	6.10	6.06	6.02	6.00	5.99	5.99	5 99	6.01	6.04	6.08	6.13

Maselspoort system (current)

Operating cost element			Water use effciency factor	Above inflation factor	Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
					Annual operating cost																					
System capacity	Ml/d					70	80	90	95	100	102	103	105	106	108	109	111	113	114	116	118	120	121	123	125	127
Raw water																										
Maselspoort (Modder river)	3 8	R/m3	1 05	1.025		101 944 500	119 420 700	137 706 995	148 991 318	160 753 790	167 244 225	173 996 710	181 021 827	188 330 584	195 934 431	203 845 284	212 075 537	220 638 087	229 546 349	238 814 283	248 456 410	258 487 838	268 924 284	279 782 102	291 078 304	302 830 591
Energy																										
Raw water PS	20	m	1 05			1 367 976	1 563 401	1 758 826	1 856 539	1 954 252	1 983 565	2 013 319	2 043 519	2 074 171	2 105 284	2 136 863	2 168 916	2 201 450	2 234 472	2 267 989	2 302 009	2 336 539	2 371 587	2 407 161	2 443 268	2 479 917
High lift PS	245	m	1			15 959 722	18 239 682	20 519 642	21 659 622	22 799 602	23 141 596	23 488 720	23 841 051	24 198 667	24 561 647	24 930 072	25 304 023	25 683 583	26 068 837	26 459 869	26 856 767	27 259 619	27 668 513	28 083 541	28 504 794	28 932 366
Booster PS	0	m				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0.75	R/kWh		1.05		17 327 698	20 793 237	24 562 012	27 222 896	30 088 464	32 066 781	34 175 172	36 422 189	38 816 948	41 369 162	44 089 185	46 988 049	50 077 513	53 370 109	56 879 194	60 619 001	64 604 701	68 852 460	73 379 509	78 204 211	83 346 138
Treatment	mg/l	R/kg																								
Lime	60	2 8		1																						
Poly	10	15		1																						
Chlorine	7	22		1																						
Total						13 745 900	15 709 600	17 673 300	18 655 150	19 637 000	19 931 555	20 230 528	20 533 986	20 841 996	21 154 626	21 471 945	21 794 025	22 120 935	22 452 749	22 789 540	23 131 383	23 478 354	23 830 529	24 187 987	24 550 807	24 919 069
Maintenance & Transport	Capital split	% maintenance																								
	70%	0.50%		1		2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000
Total CAPEX	15%	1%		1		600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000
	15%	4%		1		4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000
(including reuse pipeline)		800 000 000				8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000
Salaries		7 000 000				7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000
Total O&M cost						148 218 098	171 123 537	195 142 306	210 069 364	225 679 255	234 442 560	243 602 410	253 178 003	263 189 528	273 658 219	284 606 414	296 057 610	308 036 535	320 569 208	333 683 018	347 406 794	361 770 892	376 807 273	392 549 598	409 033 323	426 295 798
Unit variable cost		R/kl				5.21	5.34	5.48	5.62	5.77	5.92	6.07	6.24	6.40	6 57	6.75	6.93	7.12	7.32	7.52	7.73	7.94	8.16	8.39	8.63	8.88
Unit O&M cost		R/kl				5.80	5.86	5.94	6 06	6.18	6 33	6.48	6.63	6.79	6 96	7.13	7.31	7.49	7.68	7 88	8 08	8.29	8 51	8.73	8 96	9 20
Finance cost	Int. rate	10%				92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078	92 642 078
Total O&M and finance cost		1				240 860 176	263 765 615	287 784 384	302 711 442	318 321 333	327 084 638	336 244 488	345 820 081	355 831 606	366 300 297	377 248 492	388 699 688	400 678 613	413 211 286	426 325 096	440 048 872	454 412 970	469 449 351	485 191 676	501 675 401	518 937 876
Unit rate		R/kl				9.43	9 03	8.76	8.73	8.72	8.83	8.94	9.06	9.19	9.32	9.45	9.60	9.74	9.90	10.06	10.23	10.41	10 60	10.79	10 99	11 20

Maselspoort system (future)

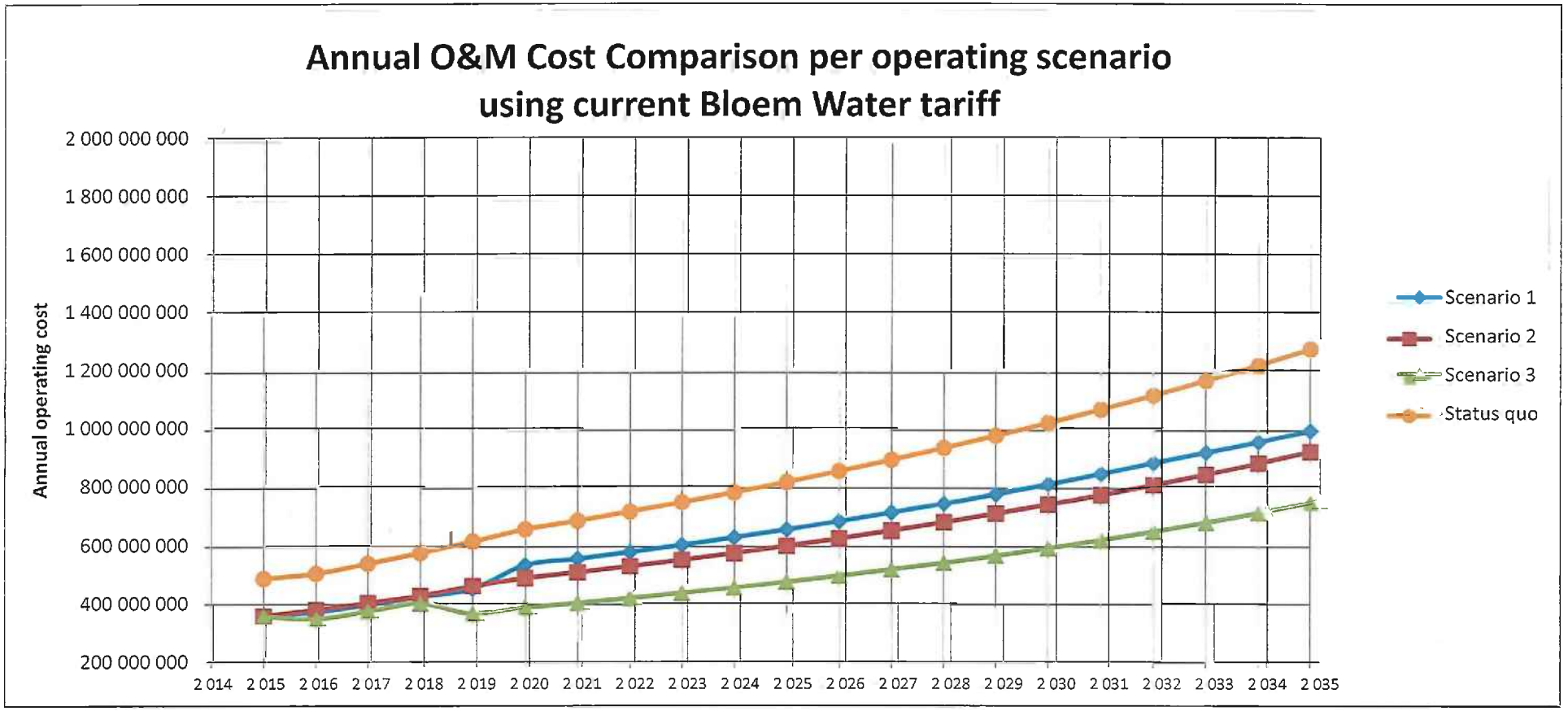
Operating cost element				Year																		
				2 015	2 016	2 017	2 018	2 019	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027	2 028	2 029	2 030	2 031	2 032	2 033	2 034	2 035
				Annual operating cost																				
System capacity	Ml/d			70	80	90	95	100	102	103	105	106	108	109	111	113	114	116	118	120	121	123	125	127
Raw water																								
Internal transfer	0.01 R/m3	1.05	1	268 275	306 600	344 925	364 088	383 250	388 999	394 834	400 756	406 768	412 869	419 062	425 348	431 728	438 204	444 777	451 449	458 221	465 094	472 070	479 151	486 339
Energy																								
Raw water PS	20 m	1 05		1 367 976	1 563 401	1 758 826	1 856 539	1 954 252	1 983 565	2 013 319	2 043 519	2 074 171	2 105 284	2 136 863	2 168 916	2 201 450	2 234 472	2 267 989	2 302 009	2 336 539	2 371 587	2 407 161	2 443 268	2 479 917
High lift PS	245 m	1		15 959 722	18 239 682	20 519 642	21 659 622	22 799 602	23 141 596	23 488 720	23 841 051	24 198 667	24 561 647	24 930 072	25 304 023	25 683 583	26 068 837	26 459 869	26 856 767	27 259 619	27 668 513	28 083 541	28 504 794	28 932 366
Low lift PS	10 m	1		651 417	744 477	837 536	884 066	930 596	944 555	958 723	973 104	987 701	1 002 516	1 017 554	1 032 817	1 048 310	1 064 034	1 079 995	1 096 195	1 112 638	1 129 327	1 146 267	1 163 461	1 180 913
DAF recycle	60 m	1.05		410 393	469 020	527 648	556 962	586 275	595 070	603 996	613 056	622 251	631 585	641 059	650 675	660 435	670 342	680 397	690 603	700 962	711 476	722 148	732 980	743 975
Ozone generation	2 7 kW/Ml			1 238 192	1 415 077	1 591 962	1 680 404	1 768 846	1 795 379	1 822 310	1 849 644	1 877 389	1 905 550	1 934 133	1 963 145	1 992 592	2 022 481	2 052 818	2 083 610	2 114 865	2 146 588	2 178 786	2 211 468	2 244 640
Total	0 75 R/kWh		1.05	19 627 700	23 553 240	27 822 265	30 836 344	34 082 275	36 323 184	38 711 434	41 256 710	43 969 339	46 860 323	49 941 389	53 225 036	56 724 582	60 454 223	64 429 088	68 665 301	73 180 044	77 991 632	83 119 582	88 584 694	94 409 138
Treatment	mg/l R/kg																							
Lime	60 2 8		1																					
Poly	10 15		1																					
Chlorine	7 22		1																					
Ozone (LOX)	80 2		1																					
GAC	3 5 25		1																					
Total				18 383 225	21 009 400	23 635 575	24 948 663	26 261 750	26 655 676	27 055 511	27 461 344	27 873 264	28 291 363	28 715 734	29 146 470	29 583 667	30 027 422	30 477 833	30 935 001	31 399 026	31 870 011	32 348 061	32 833 282	33 325 781
Maintenance & Transport	Capital split % maintenance																							
	70% 0 50%		1	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000	2 800 000
Total CAPEX	15% 1%			600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000
	15% 4%			4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000	4 800 000
(including reuse pipeline)	800 000 000			8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000	8 200 000
Grant funding	200 000 000																							
Salaries	7 000 000		4	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000
Total O&M cost				53 479 200	60 069 240	67 002 765	71 349 094	75 927 275	78 567 859	81 361 779	84 318 811	87 449 371	90 764 555	94 276 185	97 996 853	101 939 977	106 119 849	110 551 698	115 251 750	120 237 290	125 526 737	131 139 713	137 097 128	143 421 258
Unit variable cost	R/kl			1.50	1.54	1.58	1.62	1.66	1.71	1 76	1 81	1 86	1.92	1 98	2 04	2 11	2 18	2 25	2 33	2.41	2.49	2.58	2 67	2.77
Unit O&M cost	R/kl			2.09	2.06	2.04	2.06	2.08	2 12	2.16	2 21	2 26	2 31	2 36	2 42	2 48	2 54	2 61	2 68	2 76	2 83	2 92	3.00	3.10
Finance cost	Int. rate 10%			69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558	69 481 558
Total O&M and finance cost	1			122 960 759	129 550 799	136 484 323	140 830 652	145 408 833	148 049 418	150 843 337	153 800 369	156 930 929	160 246 114	163 757 743	167 478 412	171 421 535	175 601 407	180 033 257	184 733 309	189 718 849	195 008 295	200 621 272	206 578 686	212 902 816
Unit rate	R/kl			4.81	4.44	4.15	4.06	3 98	4.00	4.01	4.03	4.05	4.08	4.10	4.13	4.17	4.21	4.25	4.30	4.35	4.40	4.46	4.53	4.60

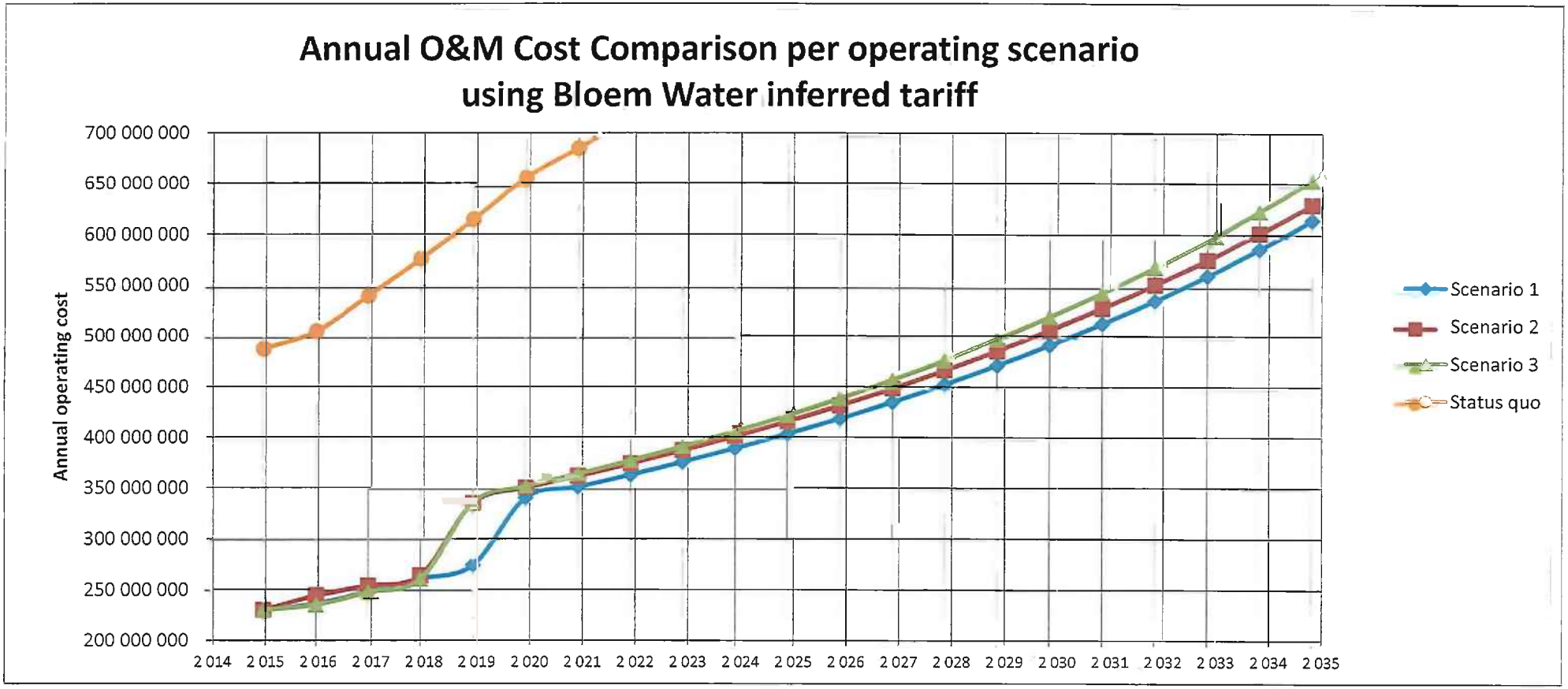
Welbedacht system (inferred cost)

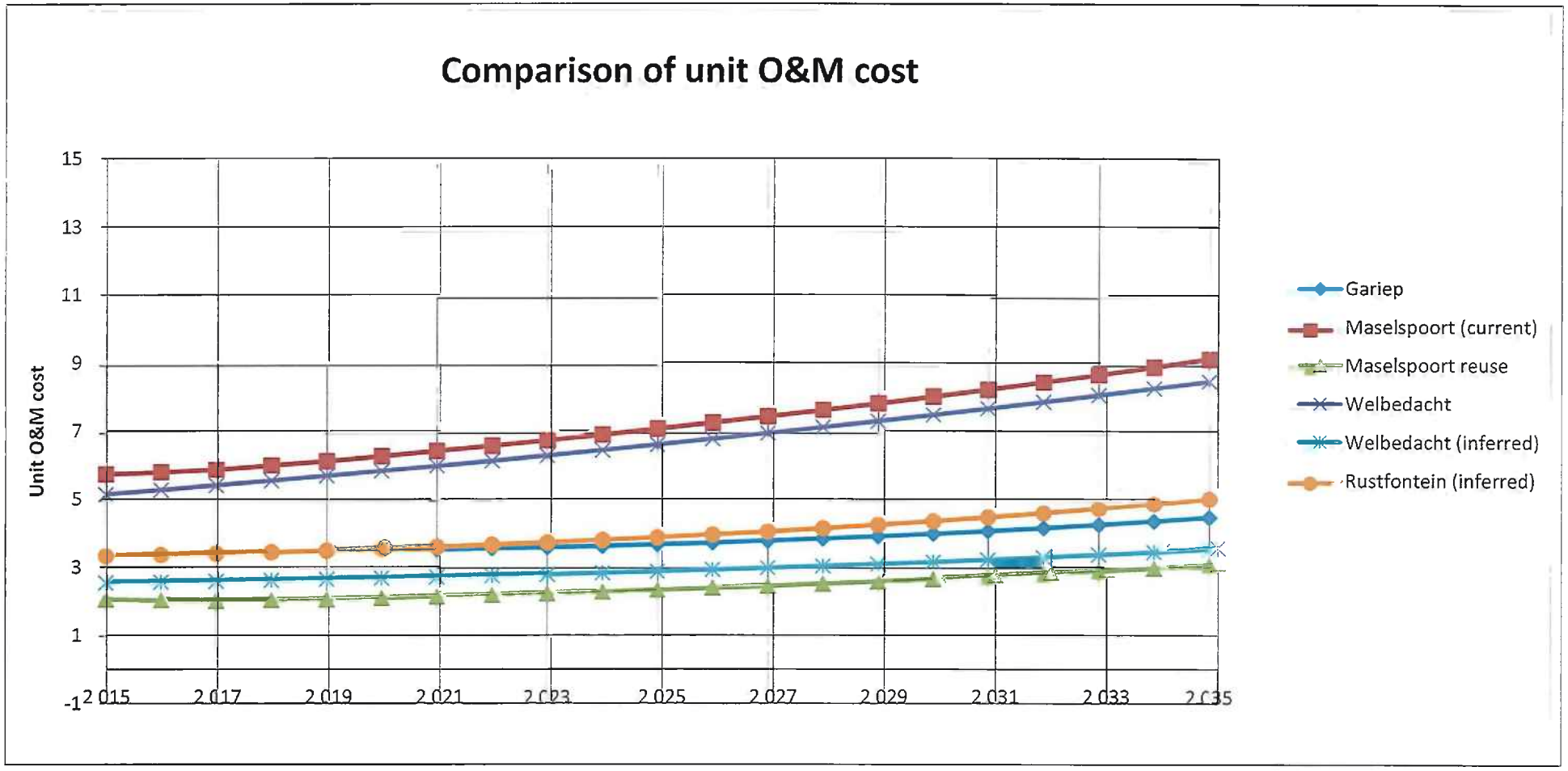
Operating cost element				Year																		
				2 015	2 016	2 017	2 018	2 019	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027	2 028	2 029	2 030	2 031	2 032	2 033	2 034	2 035
				Annual operating cost																				
System capacity	Ml/d			100	102	104	106	108	110	113	115	117	120	122	124	127	129	132	135	137	140	143	146	149
Raw water																								
Caledon river	0 2 R/m3	1 1	1	8 030 000	8 190 600	8 354 412	8 521 500	8 691 930	8 865 769	9 043 084	9 223 946	9 408 425	9 596 593	9 788 525	9 984 296	10 183 982	10 387 661	10 595 414	10 807 323	11 023 469	11 243 939	11 468 817	11 698 194	11 932 158
Energy																								
Raw water PS	25 m	1 1		2 559 139	2 610 322	2 662 528	2 715 779	2 770 094	2 825 496	2 882 006	2 939 646	2 998 439	3 058 408	3 119 576	3 181 968	3 245 607	3 310 519	3 376 730	3 444 264	3 513 149	3 583 412	3 655 081	3 728 182	3 802 746
High lift PS	245 m	1		22 799 602	23 255 594	23 720 706	24 195 120	24 679 023	25 172 603	25 676 055	26 189 576	26 713 368	27 247 635	27 792 588	28 348 440	28 915 409	29 493 717	30 083 591	30 685 263	31 298 968	31 924 948	32 563 447	33 214 715	33 879 010
Trenfontein PS	58	0.575		3 103 538	3 165 608	3 228 921	3 293 499	3 359 369	3 426 556	3 495 088	3 564 989	3 636 289	3 709 015	3 783 195	3 858 859	3 936 036	4 014 757	4 095 052	4 176 953	4 260 492	4 345 702	4 432 616	4 521 268	4 611 694
				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0.75 R/kWh		1 05	28 462 279	30 483 101	32 647 401	34 965 367	37 447 908	40 106 709	42 954 285	46 004 040	49 270 327	52 768 520	56 515 085	60 527 656	64 825 119	69 427 703	74 357 069	79 636 421	85 290 607	91 346 240	97 831 824	104 777 883	112 217 113
Treatment	mg/l R/kg																							
Lime	60 2 8		1																					
Poly	20 15		1																					
Chlorine	10 22		1																					
Total				25 112 000	25 614 240	26 126 525	26 649 055	27 182 036	27 725 677	28 280 191	28 845 794	29 422 710	30 011 165	30 611 388	31 223 616	31 848 088	32 485 050	33 134 751	33 797 446	34 473 395	35 162 863	35 866 120	36 583 442	37 315 111
Maintenance & Transport	Capital split % maintenance																							
	70% 0 50%		1	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250	8 741 250
Total CAPEX	15% 1%		1	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125	1 873 125
	15% 4%		1	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000	14 985 000
Value of works	2 497 500 000			25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375	25 599 375
Salaries	7 000 000	4	1	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000
Total O&M cost				94 203 654	96 887 316	99 727 713	102 735 297	105 921 249	109 297 530	112 876 935	116 673 155	120 700 837	124 975 653	129 514 373	134 334 942	139 456 564	144 899 789	150 686 610	156 840 565	163 386 846	170 352 417	177 766 136	185 658 894	194 063 756
Unit variable cost	R/kl			1.69	1.73	1 77	1.81	1.86	1 90	1.95	2 01	2.06	2 12	2.18	2 24	2 31	2.38	2 45	2.53	2.61	2.70	2.78	2.88	2 98
Unit O&M cost	R/kl			2 58	2.60	2.63	2.65	2.68	2.71	2 75	2 78	2 82	2.87	2.91	2 96	3.01	3 07	3.13	3.19	3.26	3.33	3.41	3.49	3.58
Finance cost	Int. rate 6%			214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388	214 714 388
Total O&M and finance cost	1			308 918 042	311 601 704	314 442 101	317 449 685	320 635 638	324 011 918	327 591 324	331 387 543	335 415 225	339 690 041	344 228 761	349 049 330	354 170 952	359 614 177	365 400 998	371 554 953	378 101 234	385 066 805	392 480 524	400 373 282	408 778 145
Unit rate	R/kl			8.46	8 37	8 28	8 20	8.12	8.04	7.97	7.90	7.84	7.79	7.74	7.69	7.65	7.62	7.59	7.56	7.55	7.53	7.53	7 53	7 54
Current MMM tariff			1.025	5.21	5.34	5 47	5 61	5.75	5.89	6.04	6.19	6.35	6 51	6.67	6.84	7.01	7.18	7.36	7.55	7.73	7 93	8.13	8.33	8 54

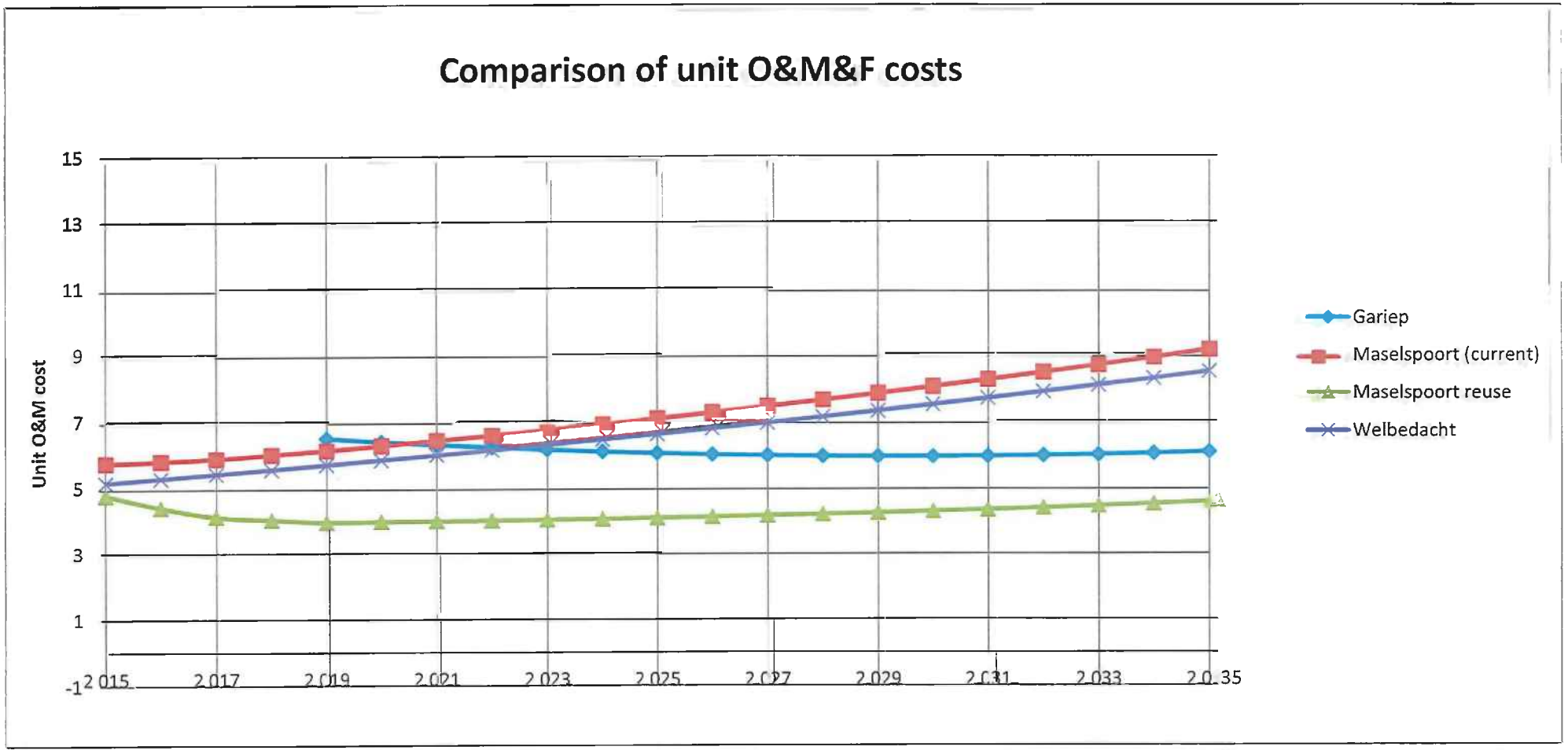
Rustfontein system (inferred cost)

Operating cost element				Year																		
				2 015	2 016	2 017	2 018	2 019	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027	2 028	2 029	2 030	2 031	2 032	2 033	2 034	2 035
				Annual operating cost																		
System capacity	Ml/d			58	60	62	63	65	67	69	71	73	76	78	80	83	85	88	90	93	96	99	102	105
Raw water																								
Caledon river	0.2	R/m3	1.27	1	5 377 180	5 538 495	5 704 650	5 875 790	6 052 063	6 233 625	6 420 634	6 613 253	6 811 651	7 016 000	7 226 480	7 443 275	7 666 573	7 896 570	8 133 467	8 377 471	8 628 795	8 887 659	9 154 289	9 428 918	9 711 785
Energy																								
Tienfontein PS	58	m	1.27		3 975 767	4 095 040	4 217 891	4 344 428	4 474 760	4 609 003	4 747 273	4 889 692	5 036 382	5 187 474	5 343 098	5 503 391	5 668 493	5 838 548	6 013 704	6 194 115	6 379 938	6 571 337	6 768 477	6 971 531	7 180 677
Novo PS	132	m	1.22		8 692 065	8 952 827	9 221 411	9 498 054	9 782 995	10 076 485	10 378 780	10 690 143	11 010 847	11 341 173	11 681 408	12 031 850	12 392 806	12 764 590	13 147 528	13 541 953	13 948 212	14 366 658	14 797 658	15 241 588	15 698 835
Rustfontein raw water PS	7	m	1.05		396 713	408 614	420 873	433 499	446 504	459 899	473 696	487 907	502 544	517 621	533 149	549 144	565 618	582 587	600 064	618 066	636 608	655 706	675 377	695 639	716 508
Rustfontein high lift PS	289	m			15 598 650	16 066 610	16 548 608	17 045 066	17 556 418	18 083 111	18 625 604	19 184 372	19 759 904	20 352 701	20 963 282	21 592 180	22 239 946	22 907 144	23 594 358	24 302 189	25 031 255	25 782 192	26 555 658	27 352 328	28 172 898
Total	0.75	R/kWh	1.05		28 663 195	30 999 245	33 525 684	36 258 027	39 213 056	42 408 920	45 865 247	49 603 265	53 645 931	58 018 074	62 746 547	67 860 391	73 391 013	79 372 380	85 841 229	92 837 289	100 403 529	108 586 416	117 436 209	127 007 260	137 358 352
Treatment	mg/l	R/kg																						
Lime	60	2.8	1																					
Poly	10	15																						
Chlorine	10	22	1																					
Total					11 389 460	11 731 144	12 083 078	12 445 570	12 818 938	13 203 506	13 599 611	14 007 599	14 427 827	14 860 662	15 306 482	15 765 676	16 238 647	16 725 806	17 227 580	17 744 408	18 276 740	18 825 042	19 389 793	19 971 487	20 570 632
Maintenance & Transport	Capital split	% maintenance																						
	70%	0.50%			6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000	6 475 000
Total CAPEX	15%	1%			1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500	1 387 500
	15%	4%			11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000	11 100 000
Value of works	1 850 000 000				18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500	18 962 500
Salaries	7 000 000		1		7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000	7 000 000
Total O&M cost					71 392 335	74 231 384	77 275 912	80 541 887	84 046 557	87 808 551	91 847 992	96 186 617	100 847 909	105 857 237	111 242 009	117 031 842	123 258 732	129 957 256	137 164 777	144 921 668	153 271 564	162 261 617	171 942 791	182 370 165	193 603 269
Unit variable cost		R/kl			2.15	2.21	2.28	2.36	2.44	2.52	2.61	2.70	2.79	2.89	3.00	3.11	3.22	3.35	3.47	3.61	3.75	3.90	4.05	4.21	4.38
Unit O&M cost		R/kl			3.37	3.40	3.44	3.48	3.53	3.58	3.63	3.69	3.76	3.83	3.91	3.99	4.08	4.18	4.28	4.39	4.51	4.64	4.77	4.91	5.06
Finance cost	Int. rate	6%			159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695	159 047 695
Total O&M and finance cost		1			230 440 030	233 279 079	236 323 607	239 589 582	243 094 252	246 856 246	250 895 687	255 234 312	259 895 604	264 904 931	270 289 704	276 079 537	282 306 427	289 004 951	296 212 472	303 969 363	312 319 259	321 309 312	330 990 486	341 417 860	352 650 964
Unit rate		R/kl			10.89	10.70	10.52	10.36	10.20	10.06	9.93	9.80	9.69	9.59	9.50	9.42	9.35	9.30	9.25	9.22	9.19	9.18	9.18	9.20	9.22
Current MMM tariff			1.025		5.21	5.34	5.47	5.61	5.75	5.89	6.04	6.19	6.35	6.51	6.67	6.84	7.01	7.18	7.36	7.55	7.73	7.93	8.13	8.33	8.54


Annual O&M Cost Comparison per operating scenario using current Bloem Water tariff
Annual operating cost
2 000 000 000
1 800 000 000
1 600 000 000
1 400 000 000
1 200 000 000
1 000 000 000
800 000 000
600 000 000
400 000 000
200 000 000
2 014 2 015 2 016 2 017 2 018 2 019 2 020 2 021 2 022 2 023 2 024 2 025 2 026 2 027 2 028 2 029 2 030 2 031 2 032 2 033 2 034 2 035
Scenario 1
Scenario 2
Scenario 3
Status quo


Annual O&M Cost Comparison per operating scenario using Bloem Water inferred tariff
Annual operating cost
700 000 000
650 000 000
600 000 000
550 000 000
500 000 000
450 000 000
400 000 000
350 000 000
300 000 000
250 000 000
200 000 000
2 014
2 015
2 016
2 017
2 018
2 019
2 020
2 021
2 022
2 023
2 024
2 025
2 026
2 027
2 028
2 029
2 030
2 031
2 032
2 033
2 034
2 035
Scenario 1
Scenario 2
Scenario 3
Status quo


Comparison of unit O&M cost
Unit O&M cost
15
13
11
9
7
5
3
1
-1
2 015
2 017
2 019
2 021
2 023
2 025
2 027
2 029
2 031
2 033
2 035
Gariep
Maselspoort (current)
Maselspoort reuse
Welbedacht
Welbedacht (inferred)
Rustfontein (inferred)


Comparison of unit O&M&F costs
Unit O&M cost
15
13
11
9
7
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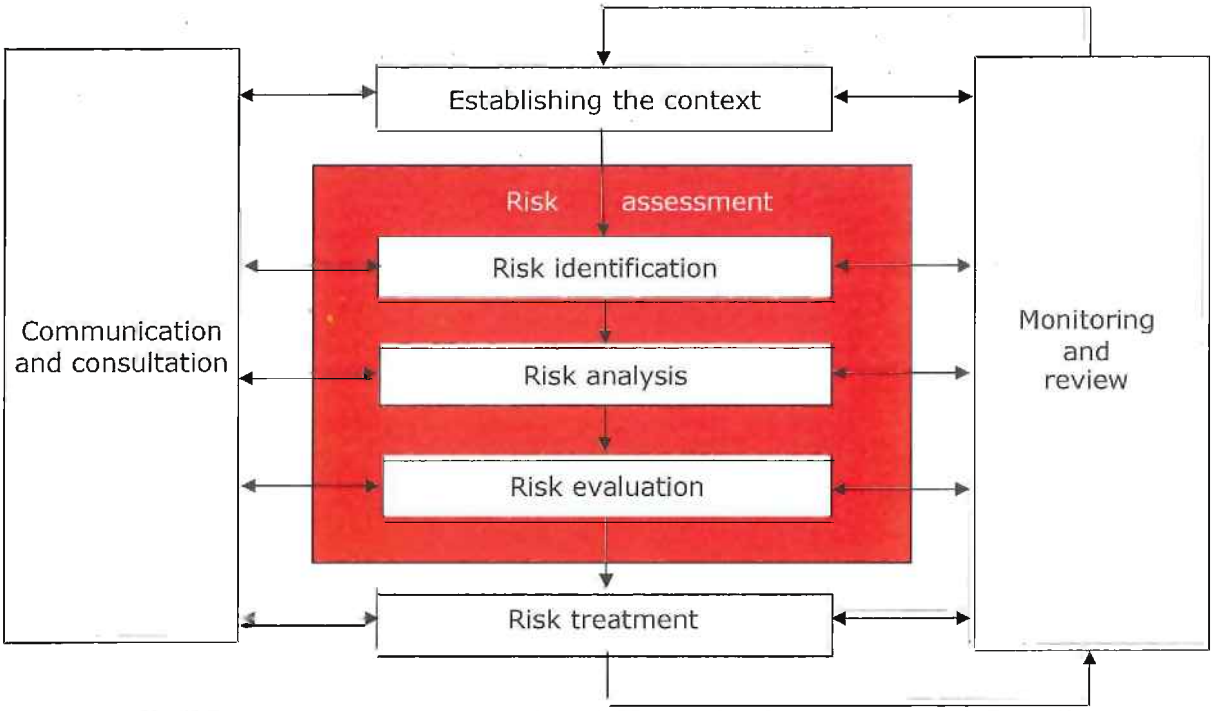
2 035
Gariep
Maselspoort (current)
Maselspoort reuse
Welbedacht

Annexure F – Risk assessment report

PROJECT NAME
Risk Assessment
Risk Management Process



Source: ISO 31000 Risk management — Principles and guidelines on implementation

BIGEN AFRICA
Risk Assessment / Register

#	Risk Name	Risk Description	Root Cause(s)	Consequence(s)	Primary Consequence Type	Secondary Consequence Type	Existing Controls	Consequence	Probability	Risk Rating	Risk Level	Action(s)	Responsible Person
001	**Growth rate outstrips current available supply.**	Growth Rate between 1% and 2% until 2035 • Bloemfontein • Thaba nchu • Botshabelo	Growth within the area	Water shortages and restrictions	Reputation/ Social/ Community	Schedule		4	4	21	High		
002	**Reduction in WCDM targets**	WCDM targets to reduce NRW and losses • Bloemfontein • Thaba nchu • Botshabelo			Reputation/ Social/ Community	Environment		4	3	18	Significant		
003	**Failure to implement water reuse in Bloemfontein**	Level of water reuse in Bloemfontein to increase from two WWTW listed below: The reuse will form a new partial base load for Bloemfontein. • Bloemspruit WWTW • North eastern WWTW The peak transfer rate to be allowed for in the total transfer from both WWTW is 90 Ml/d, ***** Ml/d form NW WWTW and ***** Ml/d from Bloemspruit WWTW.	Development and growth	Insufficient water to supply developments and impact to economy	Reputation/ Social/ Community	Legal & Regulatory		5	3	22	High		
004	**Resource integration and optimisation**	In order to optimally utilise resources the intention is to constrain/limit the potable water supply from Bloem Water and thereby maximise potable water reuse from Maselspoort WTW. Bloem Water will in future only be used as partial base load and fill in when required	Lack of exposure to the greater picture to optimise water supply in the greater area under MMM.	Current and forecast issued will not be resolved with a long term picture in mind	Legal & Regulatory	Quality and Technical Integrity		5	4	24	High		
005	**Water supply agreement and Billing**	Changes to the water supply agreement from Bloem Water to remove raw water billing and limit to %abstraction. Change to current agreement required	Current rates are high and need to be adjusted to leverage benefits	High cost of water supply to the area and impact on project feasibility	Cost	Reputation/ Social/ Community		4	3	18	Significant		
006	**Abstraction approval for increased abstraction from Maselspoort**	Approval will be given for WULA (reuse) by DWS and increased abstraction from Maselspoort. Discussions and application for IWULA needs to commence after completion of water balance	Insufficient water supply to meet demand	Water shortages and restrictions	Environment	Cost		2	2	8	Low		
007	**Abstraction approval for water use from Gariep Dam**	Approval will be given for WULA by DWS for Gariep dam. WULA submission to commence after completion of water balance	To provide sufficient water	Water shortages and restrictions	Environment	Legal & Regulatory		3	2	9	Medium		
008	**Insufficient water in Gariep dam**	Surplus water is available in Gariep dam for allocation to MMM.	Isolation of reviewing only one water sauce to provide the needs of MMM	Possible water shortages long term due to short term solutions	Environment	Reputation/ Social/ Community		3	2	9	Medium		
009	**Project Funding from own source insufficient**	Sufficient internal funding is not available for MMM to fund Gariep project. External funding to be sourced. Separate specialist firm to advise of funding strategy and securing funders/funding	Lack of available funds due to the scope of the project and programme	Delayed implementation and water shortages being realised	Cost	Schedule		2	5	18	Significant		
010	**Water supply deficit in water supply to greater MMM**	Based on current resource capacity (yield) of ******* Mm3/a and treatment and transfer system capacity of ***** Ml/d it the deficit predicted for the greater MMM is 170 Ml/d in 2035. The Gariep scheme size should be based on an AADD of 170 Ml/d with not allowance to transfer peaks. Peak demand will be supplied from Welbedach and Maselspoort treatment systems.	Existing water supply is insufficient to accommodate perceived growth	Water shortages and restrictions	Reputation/ Social/ Community	Quality and Technical Integrity		5	5	25	High		
011	**Insufficient existing treatment capacity**	The following is assumed to be the current treatment capacity (peak and average) Ml/d: Maselspoort WTW: 100 (peak), 80 (average) Welbedacht WTW: 145 (peak), 100 (average) (Constrained during peak wet period) Rustfontein WTW: 100 (peak), 80 (average)	No planned upgrades to existing facilities	Water shortages and restrictions	Quality and Technical Integrity	Safety & Health		5	5	25	High		
012	**Delayed implementation of Maselspoort Treatment capacity and process upgrade**	Planned Future treatment capacity: Maselspoort WTW: 140 (peak), 100 (average) Welbedacht WTW: 145 (peak), 100 (average) (Constrained during peak wet period) Rustfontein WTW: 100 (peak), 80 (average) Gariep WTW: 160 (peak), 160	Need to re-use water to provide sufficient water supply	Water shortages and restrictions	Quality and Technical Integrity	Safety & Health		5	5	25	High		
013	**Modder River no water releases downstream in winter months**	Modder River – No releases downstream from Rustfontein, as rivers are completely dry during winter months	Rivers run dry in winter months	Water shortages and restrictions	Environment	Reputation/ Social/ Community		2	5	16	Significant		
014	**No existing dam to do releases - Renostersprui**	Renostersprui – There is currently no dam to do any releases. Abstraction will only be possible with natural run-off	No existing dam to do any release	Only abstraction will be possible	Environment	Reputation/ Social/ Community		4	5	20	High	Construction transfer scheme to Mockes dam	
015	**Impact of increased abstraction at Maselspoort on irrigation allocations**	Water for reuse is not taken form an existing river, but directly from the outlet of the WWTW's. The irrigation allocations are therefore not foreseen to be impacted. WULA to be approved for direct transfer of effluent.	water not taken form existing river		Environment	Safety & Health				#N/A	#N/A		
017	**Water demand growth rate scenario**	Design horizon of 20 years was assumed for Gariep system (2035)			Schedule	Cost		2	3	6	Medium		
018	**Project Funding from grant funding sources insufficient**	Sufficient internal funding is not available for MMM to fund Gariep project. External funding to be sourced. Separate specialist firm to advise of funding strategy and securing funders/funding	Lack of available funds due to the scope of the project and programme	Delayed implementation and water shortages being realised	Cost	Schedule		5	5	25	High		
019	**Project Funding from commercial sources insufficient**	Sufficient internal funding is not available for MMM to fund Gariep project. External funding to be sourced. Separate specialist firm to advise of funding strategy and securing funders/funding	Lack of available funds due to the scope of the project and programme	Delayed implementation and water shortages being realised	Cost	Schedule		5	5	25	High		
020	**DWS support of Gariep augmentaiton project**	Sufficient internal funding is not available for MMM to fund Gariep project. External funding to be sourced. Separate specialist firm to advise of funding strategy and securing funders/funding	Lack of available funds due to the scope of the project and programme	Delayed implementation and water shortages being realised	Cost	Schedule		5	5	25	High		

Project NAME
Risk Assessment
Risk Matrix

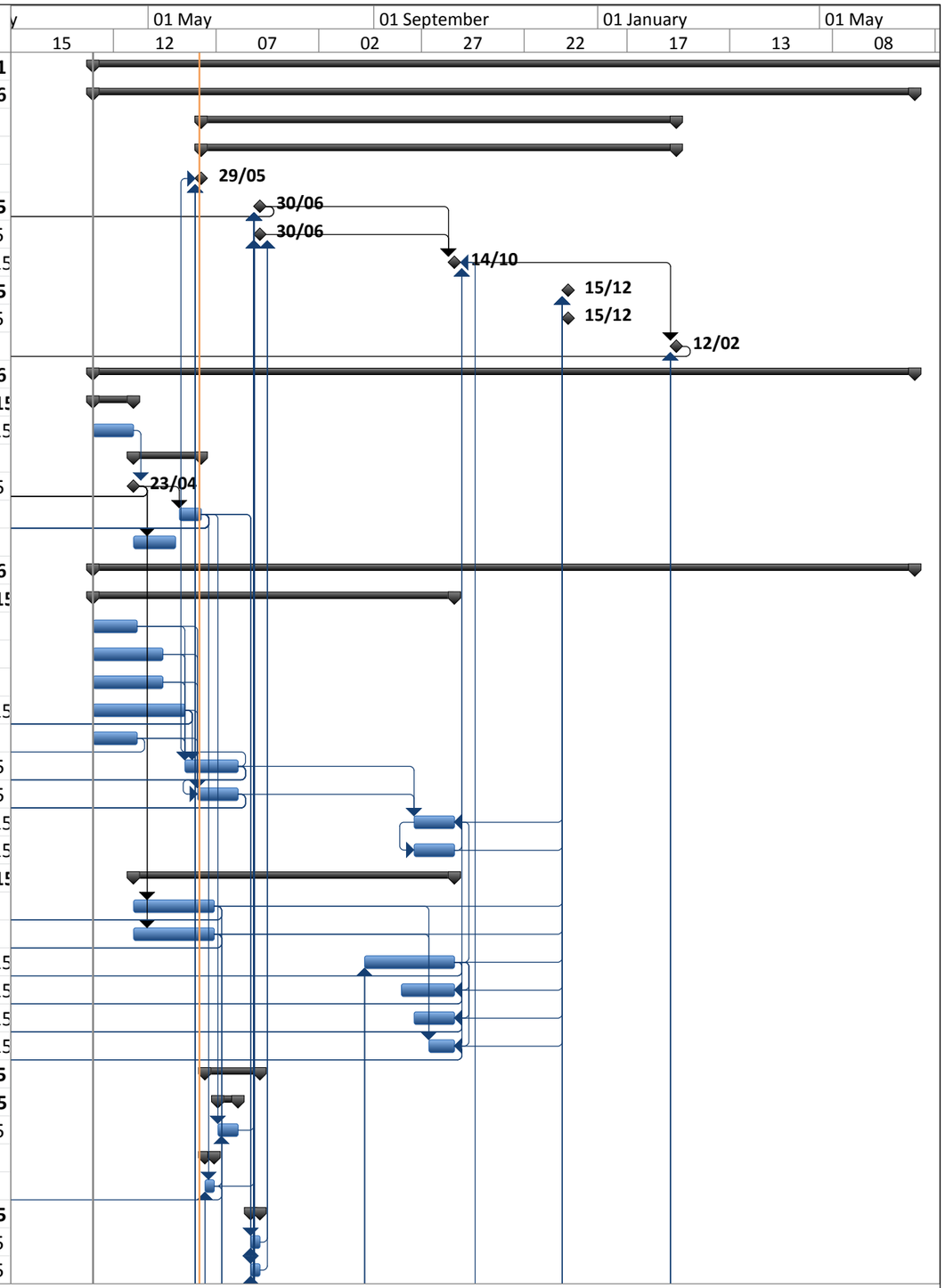
CONSEQUENCE TYPE	CONSEQUENCE				
	1 - Insignificant	**2 - Minor**	**3 - Moderate**	**4 - Major**	**5 - Extreme**
Schedule	Less than 1% impact on overall project timeline	May result in overall project timeline overrun equal to or more than 1% and less than 5%	May result in overall project timeline overrun of equal to or more than 5% and less than 20%	May result in overall project timeline overrun of equal to or more than 20% and less than 50%	May result in overall project timeline overrun of 50% or more
Cost	Less than 1% impact on the budget of the project	May result in overall project budget overrun equal to or more than 1% and less than 5%	May result in overall project budget overrun of equal to or more than 5% and less than 20%	May result in overall project budget overrun of equal to or more than 20% and less than 50%	May result in overall project budget overrun of 50% or more
Quality and Technical Integrity	No significant impact on quality of deliverables or effect on production	Quality issues that can be addressed prior to handover or could affect production by more than 1% and less than 5%	Quality issues that can be addressed during ramp-up or could affect production by more than 5% and less than 10%	Quality issues that require significant intervention to maintain performance or could affect production by more than 10% and less than 20%	Quality issues that require significant intervention to achieve performance or could affect production by 20% or more
Safety/Health	First aid case / Exposure to minor health risk	Medical treatment case / Exposure to major health risk	Lost time injury / Reversible impact on health	Single fatality or loss of quality of life / Irreversible impact on health	Multiple fatalities / Impact on health ultimately fatal
Environment	Minimal environmental harm - L1 incident	Material environmental harm - L2 incident remediable short term	Serious environmental harm - L2 incident remediable within LOM	Major environmental harm - L2 incident remediable post LOM	Extreme environmental harm - L3 incident irreversible
Legal & Regulatory	Low level legal issue	Minor legal issue; non compliance and breaches of the law	Serious breach of law; investigation/report to authority, prosecution and or moderate penalty possible	Major breach of the law; considerable prosecution and penalties	Very considerable penalties and prosecutions. Multiple law suits and jail terms
Reputation/Social/Community	Slight impact - public awareness may exist but no public concern	Limited impact - local public concern	Considerable impact - regional public concern	National impact - national public concern	International impact - international public attention

PROBABILITY		RISK LEVEL				
5 - Almost Certain	90% and higher probability of occurring	11 Medium	16 Significant	20 Significant	23 High	25 High
4 - Likely	Between 60% and less than 90% of occurring	7 Medium	12 Medium	17 Significant	21 High	24 High
3 - Possible	Between 30% and less than 60% of occurring	4 Low	8 Medium	13 Significant	18 Significant	22 High
2 - Unlikely	Between 1% and less than 30% of occurring	2 Low	5 Low	9 Medium	14 Significant	19 Significant
1 - Rare	Less than 1% of occurring	1 Low	3 Low	6 Medium	10 Medium	15 Significant

Risk Level	Guidelines for Risk Matrix
(H) - High	A high risk exists that management's objectives may not be achieved. Appropriate mitigation strategy to be devised immediately.
(S) – Significant	A significant risk exists that management's objectives may not be achieved. Appropriate mitigation strategy to be devised as soon as possible.
(M) – Medium	A moderate risk exists that management's objectives may not be achieved. Appropriate mitigation strategy to be devised as part of the normal management process.
(L) – Low	A low risk exists that management's objectives may not be achieved. Monitor risk, no further mitigation required.

Annexure G – Project execution plan report

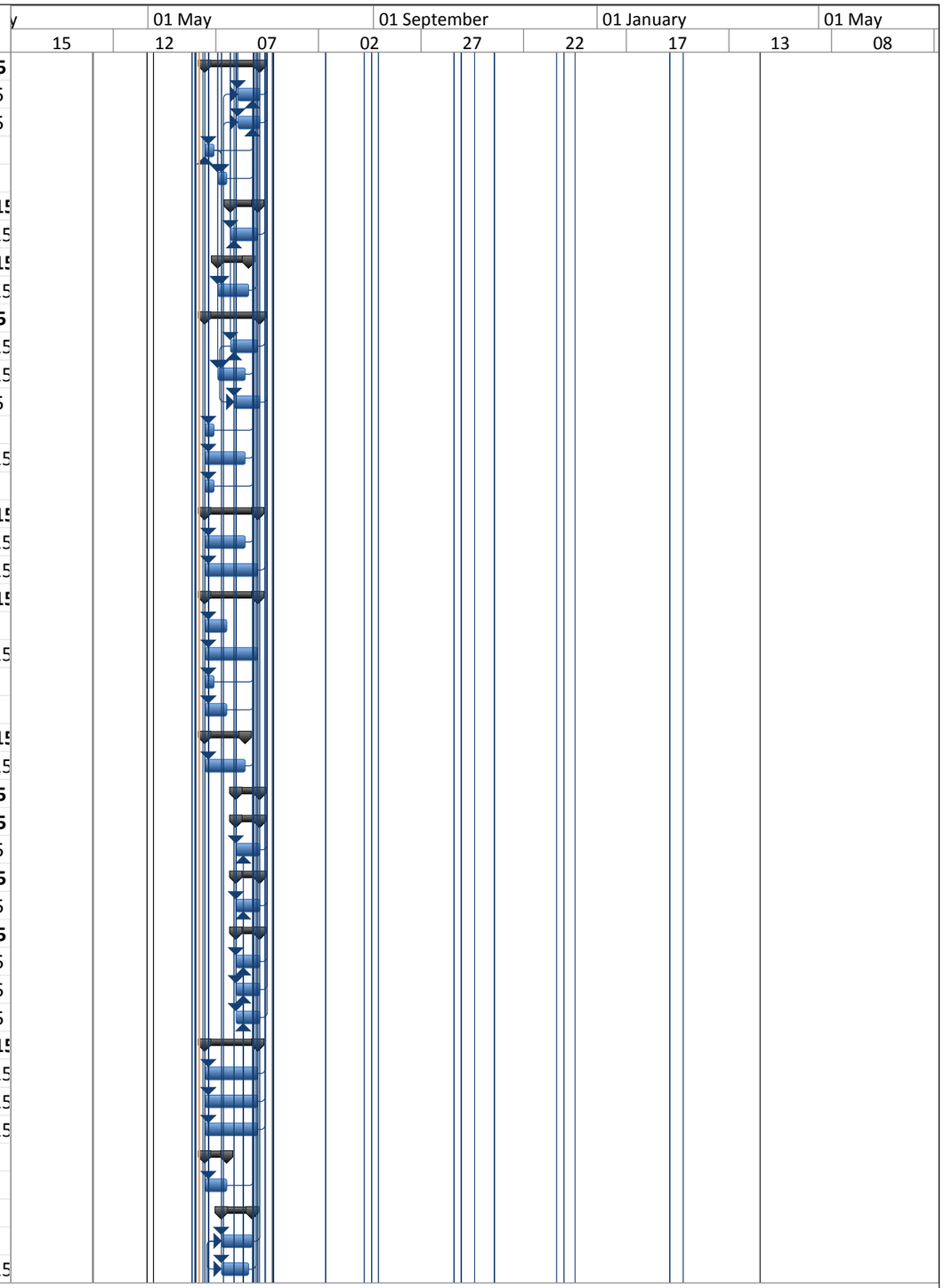
ID	Task Name	Duration	Start	Finish
1	**Mangaung Metro Municipality (MMM) Bulk Water Supply & Sanitation**	**1542 days**	**Wed 01/04/15**	**Tue 23/03/21**
2	**Programme Management**	**302 days**	**Wed 01/04/15**	**Tue 21/06/16**
3	**Key MileStones**	**169 days**	**Fri 29/05/15**	**Fri 12/02/16**
4	**Feasibility Deliverables**	**169 days**	**Fri 29/05/15**	**Fri 12/02/16**
5	Outline of Technical Feasibility Report (Draft a)	0 days	Fri 29/05/15	Fri 29/05/15
6	**Technical Feasibility Report Submission (Rev 0)**	**0 days**	**Tue 30/06/15**	**Tue 30/06/15**
7	Consolidated Draft PEP Document Submission	0 days	Tue 30/06/15	Tue 30/06/15
8	Technical Feasibility Report Document (Rev 1)	0 days	Wed 14/10/15	Wed 14/10/15
9	**Final Bankable Feasibility Document (Rev2)**	**0 days**	**Tue 15/12/15**	**Tue 15/12/15**
10	Consolidated Final PEP Document for Approval	0 days	Tue 15/12/15	Tue 15/12/15
11	Programme Approval to Proceed to Implementation Phase	0 days	Fri 12/02/16	Fri 12/02/16
12	**Feasibility**	**302 days**	**Wed 01/04/15**	**Tue 21/06/16**
13	**Initiation**	**16 days**	**Wed 01/04/15**	**Wed 22/04/15**
14	Review of Pre-Feasibility Documentation & Deliverables	16 days	Wed 01/04/15	Wed 22/04/15
15	**Planning**	**25 days**	**Thu 23/04/15**	**Fri 29/05/15**
16	Kick-Off Meeting	0 days	Thu 23/04/15	Thu 23/04/15
17	Finalise Programme Brief (Charter)	10 days	Mon 18/05/15	Fri 29/05/15
18	Organisational Structure	15 days	Thu 23/04/15	Fri 15/05/15
19	**Execution**	**302 days**	**Wed 01/04/15**	**Tue 21/06/16**
20	**Water & Sanitation Master Plan**	**136 days**	**Wed 01/04/15**	**Wed 14/10/15**
21	Population and consumer growth	18 days	Wed 01/04/15	Fri 24/04/15
22	Land development and W&S service delivery	26 days	Wed 01/04/15	Fri 08/05/15
23	Current & long term water & sanitation demands	26 days	Wed 01/04/15	Fri 08/05/15
24	MMM water balance	34 days	Wed 01/04/15	Wed 20/05/15
25	MMM salt balance (transfer inside MMM from Gariep Bloemfontein & M	18 days	Wed 01/04/15	Fri 24/04/15
26	Water Master Plan	20 days	Thu 21/05/15	Thu 18/06/15
27	Sanitation Master Plan	15 days	Thu 28/05/15	Thu 18/06/15
28	Integrated water and sanitation master plan	15 days	Wed 23/09/15	Wed 14/10/15
29	Infrastructure development plan	15 days	Wed 23/09/15	Wed 14/10/15
30	**Financial Model**	**120 days**	**Thu 23/04/15**	**Wed 14/10/15**
31	Finance Needed (Capex Cost Report)	30 days	Thu 23/04/15	Fri 05/06/15
32	Revenue Per Year (Opex Cost Report)	30 days	Thu 23/04/15	Fri 05/06/15
33	Investment Evaluation	34 days	Thu 27/08/15	Wed 14/10/15
34	Tariff model (raw water, Bloem water & potable water)	20 days	Wed 16/09/15	Wed 14/10/15
35	Funding Plan	15 days	Wed 23/09/15	Wed 14/10/15
36	Programme budget plan (Cashflow)	10 days	Thu 01/10/15	Wed 14/10/15
37	**Programme Execution Plan (PEP)**	**21 days**	**Mon 01/06/15**	**Tue 30/06/15**
38	**Integration Management**	**8 days**	**Mon 08/06/15**	**Thu 18/06/15**
39	integration management plan	8 days	Mon 08/06/15	Thu 18/06/15
40	**Scope Management**	**5 days**	**Mon 01/06/15**	**Fri 05/06/15**
41	Scope management plan	5 days	Mon 01/06/15	Fri 05/06/15
42	**Schedule management**	**3 days**	**Fri 26/06/15**	**Tue 30/06/15**
43	Basis of Schedule	3 days	Fri 26/06/15	Tue 30/06/15
44	Schedule Management Plan	3 days	Fri 26/06/15	Tue 30/06/15



Project: MMM Gariep schedule
Date: Fri 29/05/15

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline			
Split	External Tasks	Inactive Summary	Manual Summary	Progress			
Milestone	External Milestone	Manual Task	Start-only				
Summary	Inactive Task	Duration-only	Finish-only				

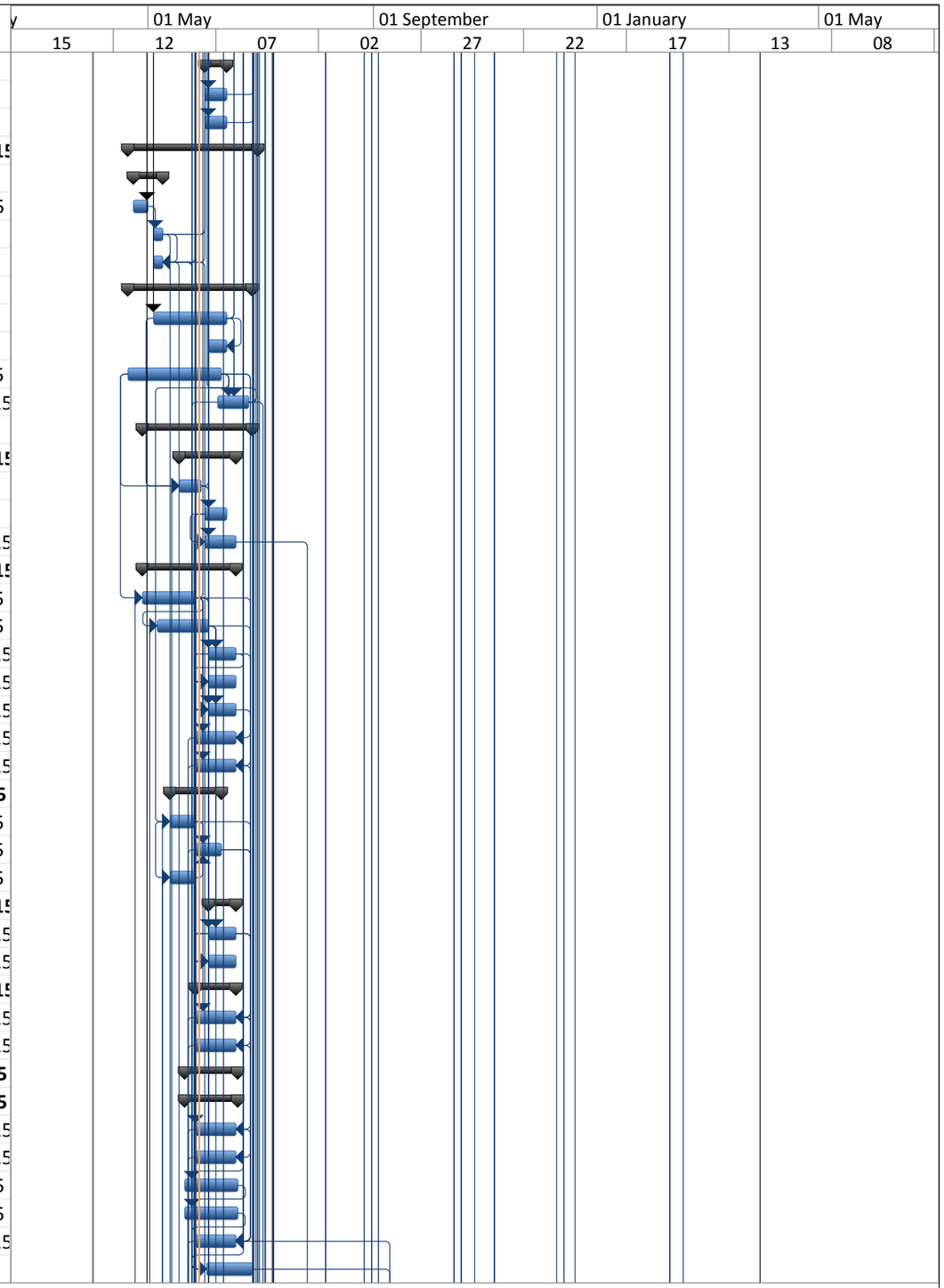
ID	Task Name	Duration	Start	Finish
45	**Cost Management**	**21 days**	**Mon 01/06/15**	**Tue 30/06/15**
46	Cost budgeting	8 days	Fri 19/06/15	Tue 30/06/15
47	Basis Of Estimate	8 days	Fri 19/06/15	Tue 30/06/15
48	Cost Break Down Structure	5 days	Mon 01/06/15	Fri 05/06/15
49	Cost management plan	5 days	Mon 08/06/15	Fri 12/06/15
50	**Quality Management**	**10 days**	**Mon 15/06/15**	**Mon 29/06/15**
51	Quality Management Plan	10 days	Mon 15/06/15	Mon 29/06/15
52	**Change Management**	**12 days**	**Mon 08/06/15**	**Wed 24/06/15**
53	Integrated change management plan & control	12 days	Mon 08/06/15	Wed 24/06/15
54	**Procurement Management**	**21 days**	**Mon 01/06/15**	**Tue 30/06/15**
55	Procurement Operating Plan	10 days	Mon 15/06/15	Mon 29/06/15
56	Procurement Work Packages	10 days	Mon 08/06/15	Mon 22/06/15
57	Commercial Conditions	10 days	Wed 17/06/15	Tue 30/06/15
58	Registers	5 days	Mon 01/06/15	Fri 05/06/15
59	Vendor List Information	15 days	Mon 01/06/15	Mon 22/06/15
60	Contracts	5 days	Mon 01/06/15	Fri 05/06/15
61	**Communications**	**20 days**	**Mon 01/06/15**	**Mon 29/06/15**
62	Communication plan	15 days	Mon 01/06/15	Mon 22/06/15
63	Stakeholders Analysis Matrix	20 days	Mon 01/06/15	Mon 29/06/15
64	**Human Resources**	**20 days**	**Mon 01/06/15**	**Mon 29/06/15**
65	acquire project team	10 days	Mon 01/06/15	Fri 12/06/15
66	develop project team	20 days	Mon 01/06/15	Mon 29/06/15
67	Roles and responsibility plan	5 days	Mon 01/06/15	Fri 05/06/15
68	Human resource management plan	10 days	Mon 01/06/15	Fri 12/06/15
69	**Document Management**	**15 days**	**Mon 01/06/15**	**Mon 22/06/15**
70	Document Management Plan	15 days	Mon 01/06/15	Mon 22/06/15
71	**SHE**	**9 days**	**Thu 18/06/15**	**Tue 30/06/15**
72	**Safety**	**9 days**	**Thu 18/06/15**	**Tue 30/06/15**
73	Safety management plan	9 days	Thu 18/06/15	Tue 30/06/15
74	**Health & Hygiene**	**9 days**	**Thu 18/06/15**	**Tue 30/06/15**
75	Health & hygiene assessment plan	9 days	Thu 18/06/15	Tue 30/06/15
76	**Environment**	**9 days**	**Thu 18/06/15**	**Tue 30/06/15**
77	Compliance	9 days	Thu 18/06/15	Tue 30/06/15
78	Studies & Investigations	9 days	Thu 18/06/15	Tue 30/06/15
79	SHE Management plan	9 days	Thu 18/06/15	Tue 30/06/15
80	**Sustainable development**	**20 days**	**Mon 01/06/15**	**Mon 29/06/15**
81	Social impacts	20 days	Mon 01/06/15	Mon 29/06/15
82	Energy and water conservation	20 days	Mon 01/06/15	Mon 29/06/15
83	Carbon Balance	20 days	Mon 01/06/15	Mon 29/06/15
84	**Security Management**	**10 days**	**Mon 01/06/15**	**Fri 12/06/15**
85	Security Management Plan	10 days	Mon 01/06/15	Fri 12/06/15
86	**Construction Management**	**12 days**	**Wed 10/06/15**	**Fri 26/06/15**
87	Construction Monitoring	12 days	Wed 10/06/15	Fri 26/06/15
88	Commissioning	10 days	Wed 10/06/15	Wed 24/06/15



Project: MMM Gariep schedule
Date: Fri 29/05/15

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline	
Split	External Tasks	Inactive Summary	Manual Summary	Progress	
Milestone	External Milestone	Manual Task	Start-only		
Summary	Inactive Task	Duration-only	Finish-only		

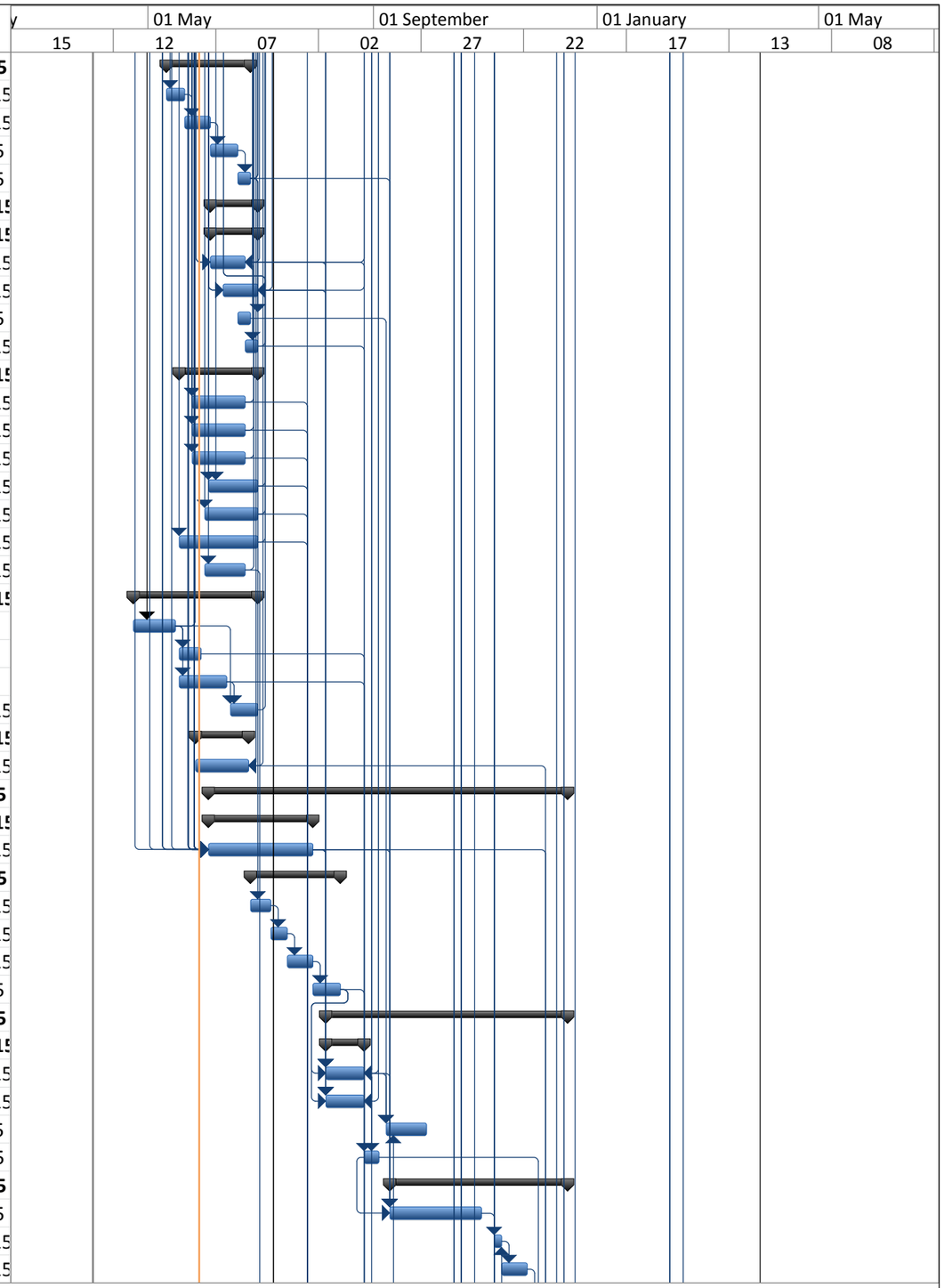
ID	Task Name	Duration	Start	Finish
89	**Governance**	**10 days**	**Mon 01/06/15**	**Fri 12/06/15**
90	Steercom	10 days	Mon 01/06/15	Fri 12/06/15
91	Programme Reviews/Audits	10 days	Mon 01/06/15	Fri 12/06/15
92	**Technical Feasibility Study Report**	**48 days**	**Mon 20/04/15**	**Mon 29/06/15**
93	**Scoping**	**10 days**	**Thu 23/04/15**	**Fri 08/05/15**
94	Scope of Work (SOW)	5 days	Thu 23/04/15	Thu 30/04/15
95	Work Breakdown Structure	5 days	Mon 04/05/15	Fri 08/05/15
96	Deliverables and acceptance criteria	5 days	Mon 04/05/15	Fri 08/05/15
97	**Engineering**	**47 days**	**Mon 20/04/15**	**Fri 26/06/15**
98	Engineering Report	30 days	Mon 04/05/15	Fri 12/06/15
99	Standards and Specifications	8 days	Wed 03/06/15	Fri 12/06/15
100	Site Wide Reports	35 days	Mon 20/04/15	Tue 09/06/15
101	Engineering Work Plan	12 days	Mon 08/06/15	Wed 24/06/15
102	**Engineering Design**	**42 days**	**Tue 28/04/15**	**Fri 26/06/15**
103	**Geotechnical**	**22 days**	**Mon 18/05/15**	**Wed 17/06/15**
104	Data validation	10 days	Mon 18/05/15	Fri 29/05/15
105	Risk Assessment	10 days	Mon 01/06/15	Fri 12/06/15
106	Geological Report	12 days	Mon 01/06/15	Wed 17/06/15
107	**Electrical**	**35 days**	**Tue 28/04/15**	**Wed 17/06/15**
108	Loads	20 days	Tue 28/04/15	Tue 26/05/15
109	HT/LT	20 days	Wed 06/05/15	Tue 02/06/15
110	Design Criteria	10 days	Wed 03/06/15	Wed 17/06/15
111	Specifications/Standards	10 days	Wed 03/06/15	Wed 17/06/15
112	Substations / Mini-subs	10 days	Wed 03/06/15	Wed 17/06/15
113	Lighting	15 days	Wed 27/05/15	Wed 17/06/15
114	Emergency Power	15 days	Wed 27/05/15	Wed 17/06/15
115	**Civil**	**20 days**	**Wed 13/05/15**	**Tue 09/06/15**
116	Design Criteria	10 days	Wed 13/05/15	Tue 26/05/15
117	Founding Strategies	10 days	Wed 27/05/15	Tue 09/06/15
118	Standards & Specifications	10 days	Wed 13/05/15	Tue 26/05/15
119	**C&I**	**10 days**	**Wed 03/06/15**	**Wed 17/06/15**
120	P&ID's	10 days	Wed 03/06/15	Wed 17/06/15
121	Line Lists & Cable Schedules	10 days	Wed 03/06/15	Wed 17/06/15
122	**Mechanical/Structural**	**15 days**	**Wed 27/05/15**	**Wed 17/06/15**
123	Pumping	15 days	Wed 27/05/15	Wed 17/06/15
124	Piping	15 days	Wed 27/05/15	Wed 17/06/15
125	**Process**	**20 days**	**Thu 21/05/15**	**Thu 18/06/15**
126	**Process Design**	**20 days**	**Thu 21/05/15**	**Thu 18/06/15**
127	Process Design Criteria	15 days	Wed 27/05/15	Wed 17/06/15
128	Process layout	15 days	Wed 27/05/15	Wed 17/06/15
129	WULA approval of abstraction point	20 days	Thu 21/05/15	Thu 18/06/15
130	Scope of work at outlet	20 days	Thu 21/05/15	Thu 18/06/15
131	HAZOP's	15 days	Wed 27/05/15	Wed 17/06/15
132	Engineering management plan	18 days	Tue 02/06/15	Fri 26/06/15



Project: MMM Gariep schedule
Date: Fri 29/05/15

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline			
Split	External Tasks	Inactive Summary	Manual Summary	Progress			
Milestone	External Milestone	Manual Task	Start-only				
Summary	Inactive Task	Duration-only	Finish-only				

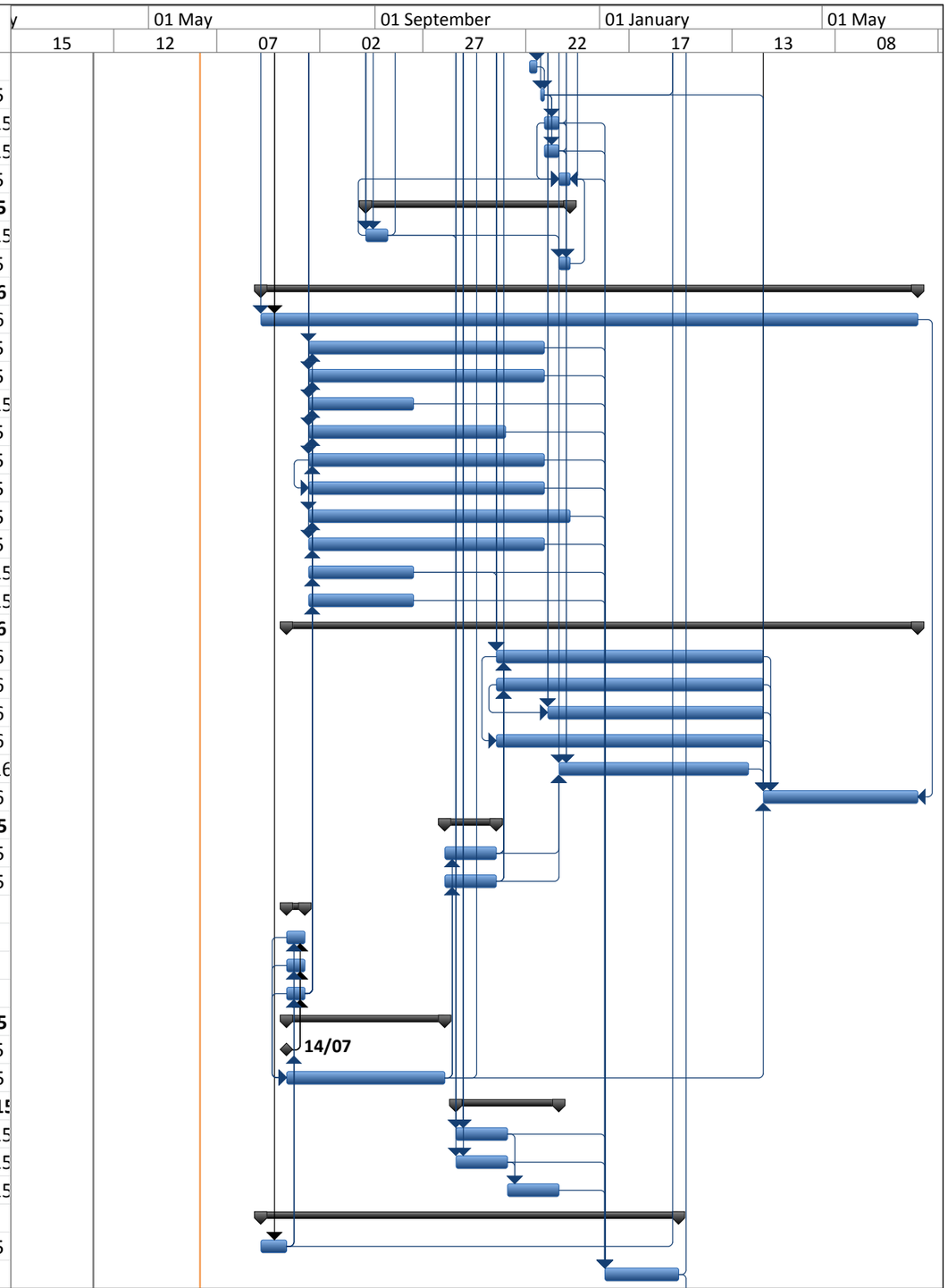
ID	Task Name	Duration	Start	Finish
133	**Schedule development**	**33 days**	**Mon 11/05/15**	**Thu 25/06/15**
134	Activity List	8 days	Mon 11/05/15	Wed 20/05/15
135	Duration estimates	10 days	Thu 21/05/15	Wed 03/06/15
136	Resource estimates	10 days	Thu 04/06/15	Thu 18/06/15
137	Programme Master Schedule Approval	5 days	Fri 19/06/15	Thu 25/06/15
138	**Estimation**	**17 days**	**Thu 04/06/15**	**Mon 29/06/15**
139	**cost estimating**	**17 days**	**Thu 04/06/15**	**Mon 29/06/15**
140	CAPEX - Class 3 - Preliminary Estimate (10-40%)	12 days	Thu 04/06/15	Mon 22/06/15
141	OPEX - Class 3 - Preliminary Estimate (10-40%)	12 days	Thu 11/06/15	Mon 29/06/15
142	Preliminary Contingency P50	5 days	Fri 19/06/15	Thu 25/06/15
143	Escalation	5 days	Tue 23/06/15	Mon 29/06/15
144	**Conditions Precedent (Preliminary Requirements)**	**30 days**	**Mon 18/05/15**	**Mon 29/06/15**
145	Water Use Licence/s	20 days	Mon 25/05/15	Mon 22/06/15
146	Archeology/SAHRA	20 days	Mon 25/05/15	Mon 22/06/15
147	Wayleaves	20 days	Mon 25/05/15	Mon 22/06/15
148	Bulk Power	18 days	Wed 03/06/15	Mon 29/06/15
149	Servitudes	20 days	Mon 01/06/15	Mon 29/06/15
150	Borrow Pit identification	30 days	Mon 18/05/15	Mon 29/06/15
151	Environmental Investigation criteria	15 days	Mon 01/06/15	Mon 22/06/15
152	**Risk Management**	**45 days**	**Thu 23/04/15**	**Mon 29/06/15**
153	Qualitative Risk Assessment	15 days	Thu 23/04/15	Fri 15/05/15
154	Risk response planning	10 days	Mon 18/05/15	Fri 29/05/15
155	Risk monitoring and control Report	20 days	Mon 18/05/15	Fri 12/06/15
156	Risk management plan	10 days	Mon 15/06/15	Mon 29/06/15
157	**Operational Readiness**	**20 days**	**Wed 27/05/15**	**Wed 24/06/15**
158	Operational Readiness Plan	20 days	Wed 27/05/15	Wed 24/06/15
159	**Bankable Feasibility Study Report**	**137 days**	**Wed 03/06/15**	**Tue 15/12/15**
160	**Engineering**	**40 days**	**Wed 03/06/15**	**Wed 29/07/15**
161	Preliminary Engineering Design (PED)	40 days	Wed 03/06/15	Wed 29/07/15
162	**Schedule Management**	**34 days**	**Fri 26/06/15**	**Thu 13/08/15**
163	Review Activity List to level 3 definition	7 days	Fri 26/06/15	Mon 06/07/15
164	Refine and Update Duration estimates	7 days	Tue 07/07/15	Wed 15/07/15
165	Refine and Update Resource estimates	10 days	Thu 16/07/15	Wed 29/07/15
166	Revised Programme Master Schedule Approval	10 days	Thu 30/07/15	Thu 13/08/15
167	**Cost Management**	**92 days**	**Thu 06/08/15**	**Tue 15/12/15**
168	**Cost estimating**	**14 days**	**Thu 06/08/15**	**Wed 26/08/15**
169	CAPEX - Class 2 - Substantive (30-70%)	14 days	Thu 06/08/15	Wed 26/08/15
170	OPEX - Class 2 - Substantive (30-70%)	14 days	Thu 06/08/15	Wed 26/08/15
171	Contingency P70	15 days	Tue 08/09/15	Tue 29/09/15
172	Revise and Finalise Escalation	6 days	Thu 27/08/15	Thu 03/09/15
173	**Enquiry (RFP)**	**68 days**	**Thu 10/09/15**	**Tue 15/12/15**
174	Prepare BOQ and RFP documents	35 days	Thu 10/09/15	Thu 29/10/15
175	Issue RFP	2 days	Fri 06/11/15	Mon 09/11/15
176	Tender Period	10 days	Tue 10/11/15	Mon 23/11/15



Project: MMM Gariep schedule
Date: Fri 29/05/15

Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress

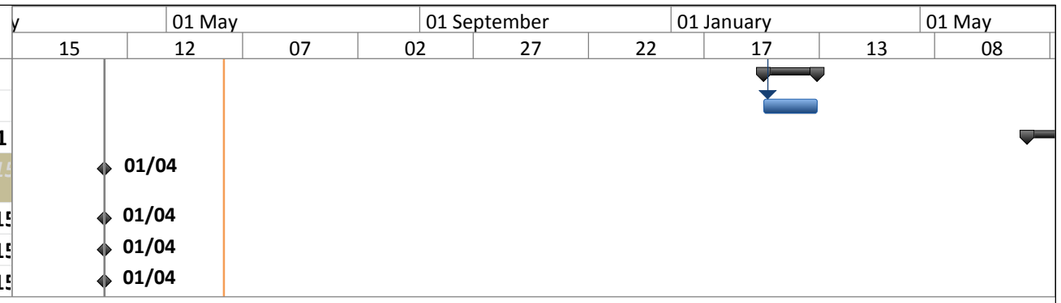
ID	Task Name	Duration	Start	Finish
177	RFP Pricing validation	4 days	Tue 24/11/15	Fri 27/11/15
178	Confirm/revise Cost	2 days	Mon 30/11/15	Tue 01/12/15
179	CAPEX - Class 1 - Definative (50-100%)	6 days	Wed 02/12/15	Wed 09/12/15
180	OPEX - Class 1 - Definative (50-100%)	6 days	Wed 02/12/15	Wed 09/12/15
181	Contingency P90	4 days	Thu 10/12/15	Tue 15/12/15
182	**Risk Management**	**78 days**	**Thu 27/08/15**	**Tue 15/12/15**
183	Quanitative Risk Analysis (QRA) - Class 2	8 days	Thu 27/08/15	Mon 07/09/15
184	Update QRA - Class 1	4 days	Thu 10/12/15	Tue 15/12/15
185	**Early Works & Statutory Approvals**	**240 days**	**Wed 01/07/15**	**Tue 21/06/16**
186	Environmental Impact Assessment	240 days	Wed 01/07/15	Tue 21/06/16
187	Geotechnical Investigations	90 days	Mon 27/07/15	Tue 01/12/15
188	Water Use Licence/s applications	90 days	Mon 27/07/15	Tue 01/12/15
189	Archeology/SAHRA studies & investigations	40 days	Mon 27/07/15	Mon 21/09/15
190	Wayleaves applications and approvals	75 days	Mon 27/07/15	Tue 10/11/15
191	Bulk Power applications	90 days	Mon 27/07/15	Tue 01/12/15
192	Sustainable Energy Solution Investigations	90 days	Mon 27/07/15	Tue 01/12/15
193	Servitudes registration	100 days	Mon 27/07/15	Tue 15/12/15
194	Borrow Pits licences	90 days	Mon 27/07/15	Tue 01/12/15
195	Cathodic Protection and AC mitigation design	40 days	Mon 27/07/15	Mon 21/09/15
196	Topographical Survey	40 days	Mon 27/07/15	Mon 21/09/15
197	**Legal & Regulatory**	**230 days**	**Tue 14/07/15**	**Tue 21/06/16**
198	Off-take agreements	90 days	Fri 06/11/15	Tue 29/03/16
199	Lease Agreements	90 days	Fri 06/11/15	Tue 29/03/16
200	Operate and Maintain Agreement (O&M)	70 days	Fri 04/12/15	Tue 29/03/16
201	Supply Agreements	90 days	Fri 06/11/15	Tue 29/03/16
202	Financing Agreements	60 days	Thu 10/12/15	Mon 21/03/16
203	Construction Agreements	60 days	Wed 30/03/16	Tue 21/06/16
204	**Project Underwriting**	**20 days**	**Fri 09/10/15**	**Thu 05/11/15**
205	National Treasury - PPP project registration	20 days	Fri 09/10/15	Thu 05/11/15
206	Preliminary Bank/Institution underwriting	20 days	Fri 09/10/15	Thu 05/11/15
207	**Council Appointments**	**8 days**	**Wed 15/07/15**	**Fri 24/07/15**
208	Project officer	8 days	Wed 15/07/15	Fri 24/07/15
209	Project sercetreriate	8 days	Wed 15/07/15	Fri 24/07/15
210	Project Advisor	8 days	Wed 15/07/15	Fri 24/07/15
211	**Due Process**	**60 days**	**Tue 14/07/15**	**Thu 08/10/15**
212	Council Resolution	0 days	Tue 14/07/15	Tue 14/07/15
213	Section 77 & 78 Application process	60 days	Wed 15/07/15	Thu 08/10/15
214	**Due Diligence Report**	**40 days**	**Thu 15/10/15**	**Wed 09/12/15**
215	Affordability Study and Findings	20 days	Thu 15/10/15	Wed 11/11/15
216	Risk Transfer Study and Findings	20 days	Thu 15/10/15	Wed 11/11/15
217	Value for Money Study and Findings	20 days	Thu 12/11/15	Wed 09/12/15
218	**Assurance & Approvals**	**148 days**	**Wed 01/07/15**	**Fri 12/02/16**
219	Technical Fesibility & Draft PEP Review and Approval	10 days	Wed 01/07/15	Tue 14/07/15
220	Bankable Feasibility Review and Approval	30 days	Mon 04/01/16	Fri 12/02/16



Project: MMM Gariep schedule
Date: Fri 29/05/15

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only
Summary	Inactive Task	Duration-only	Finish-only

ID	Task Name	Duration	Start	Finish
221	**Close-out**	**20 days**	**Mon 15/02/16**	**Fri 11/03/16**
222	Document Review & Knowledge Management	20 days	Mon 15/02/16	Fri 11/03/16
223	**External Gariep Bulk Water System Project**	**1240 days**	**Wed 22/06/16**	**Tue 23/03/21**
232	***Internal Sanitation System Upgrades (Bloemspruit***	***0 days***	***Wed 01/04/15***	***Wed 01/04/15***
570	**Internal Transfer System Upgrades (Mockes)**	**0 days**	**Wed 01/04/15**	**Wed 01/04/15**
908	**Internal Storage Systems Upgrades (Mockes)**	**0 days**	**Wed 01/04/15**	**Wed 01/04/15**
1241	**Internal Potable Water Treatment System Upgrades (Waste)**	**0 days**	**Wed 01/04/15**	**Wed 01/04/15**



Project: MMM Gariep schedule
Date: Fri 29/05/15

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Progress	
Milestone		External Milestone		Manual Task		Start-only			
Summary		Inactive Task		Duration-only		Finish-only			

PROJECT EXECUTION PLAN

For: **Implementation Phase**
Project Name: **Bulk Water Supply & Sanitation Project**
Project Number:

Author: **D.R. Sutton**
Project Officer:
Client: **MANGAUNG METRO MUNICIPALITY**
Project Sponsor:
Project Manager:

Revision Number: **Draft 0**
Approved by:

Release Date: **08 June 2015**
Print Date: 18/06/2015

Distribution	
Name	Location

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Date

Reviewed by: _____ _____
"Person/s Reviewing the Document" Date

Approved by: _____ _____
"Approver" Date

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"Person's Name" Date

Approved by: _____ _____
"Person's Name" Date

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"Person's Name" Date

Project Execution Plan (PEP)

PREFACE

Purpose of this Document

The Project Execution Plan (PEP) establishes the execution philosophy and defines the organisation, work processes and systems necessary for management of the project during Implementation.

- The information outlined in this document is used to help ensure that the project is completed in a timely and efficient manner and that the facilities designed and constructed will satisfy the project functional requirements.
- The PEP is structured to give a quick view of the project and the requirements for each phase/discipline in the project.
- The PEP is a working document and is updated and detailed as the project progresses through the different phases i.e. proposal, detailed engineering, procurement, fabrication, construction, commissioning and hand over.
- The PEP is designed to always have the latest information available. It is the project manager's responsibility to update this document and to ensure that the latest information is available.
- The final update of the PEP will be for the Project Close-out.

List of Abbreviations and Acronyms

Abbreviations and Acronyms	
BWSSP	Bulk Water Supply and Sanitation Project
CAD	Computer Aided Design
CAPEX	Capital Expenditure
CAR	Corrective Action Request
CBS	Cost Breakdown Structure
CEMP	Construction Environmental Management Plan
CIDB	Construction Industry Development Board
COID	Compensation for Occupational Injuries and Diseases Act
CPM	Critical Path Method
DEA	Department of Environmental Affairs
DOC	Document
DSTI	Daily Safety Task Instruction
EDC	Engineering Design Criteria
EMPr	Environmental Management Programme
Etc.	etcetera
FIDIC	International Federation of Consulting Engineers
Forex	Foreign Exchange
HAZOP	Hazzard and Operability Study
HR	Human Resources
IFA	Issued For Approval
IFCR	Issued For Client Review
IFIR	Issued For Internal Review
IM	Information Management
IR	Industrial Relations
ISO	International Standard Organisation
JSA	Job Safety Analysis
KPI	Key Performance Indicator
LTI	Lost Time Injury
MCC	Motor Control Centre
MFMA	Municipal Finance Management Act
MMM	Manaung Metro Municipality
NCR	Non-conformance report
OD	Operating Division
OHS Act	Occupational Health and Safety Act
OME	Order of Magnitude Estimate
OPEX	Operations Expenditure
OR	Operational Readiness
ORS	Owner's Requirement Specification
P&G	Preliminary and General
PDF	Portable Document Format
PEP	Project Execution Plan
PES	Project Environmental Specification
PFMA	Public Finance Management Act
PLC	Programmable Logic Controller
PMBOK	Project management book of knowledge
PMI	Project management institute
POP	Procurement Operating Plan

PPE	Personal Protective Equipment
PPP	Public-Private Partnership
PPPFA	Preferential Procurement Policy Framework
QA/QC	Quality Assurance / Quality Control
QCP	Quality Control Plan
QMP	Quality Management Plan
QMS	Quality Management System
QRA	Quantitative Risk Analysis
QRR	Quantitative Risk Review
RACI	Responsibility Matrix – Accountable, Responsible, Consult, Inform
RSA	Republic of South Africa
SES	Standard Environmental Specification
SHE	Safety, Health and Environment
SI	Site Instruction
STI	Safety Task Instruction
TRM	Technical Risk Management
UIF	Unemployment Insurance Fund
USD / US$	US Dollars
ZAR / R	South African Rand

Summary

Insert Text

The Project Charter

The Project Charter formally authorises the work of the project to begin (or continue) and gives the project manager authority to do his job. The charter further defines the scope, objectives, and overall approach for the work to be completed. It is a critical element for initiating, planning, executing, controlling, and assessing implementation. It is the single point of reference on the implementation for goals and objectives, scope, organisation, estimates, work plan, and budget. In addition, it serves as a contract between the project team, the project sponsors and the clients, stating what will be delivered according to the budget, time constraints, risks, resources, and standards agreed upon for the study.

Please refer to the project charter for the Mangaung Metro Municipality Bulk Water Supply and Sanitation Project that has been prepared.

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a) ---

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1. PROJECT DETAILS

1.1. CONTRACTING PARTIES

1.1.1. Client

Mangaung Metro Municipality

Insert text

1.1.2. Project Manager and Engineering Services

Bigen Africa Services (Pty) Ltd.

Location: Allan Cormack Street, the Innovation Hub, Persequor, Pretoria.

Representative: Mias van der Walt

1.1.3. Scope Statement

Insert text

1.1.3.1. Project Benefits

Insert Text

1.1.3.1.1. Inclusions

Insert Text

1.1.3.1.2. Exclusions

Insert text

1.1.3.1.3. Work Breakdown Structure

The project Work Breakdown Structure (WBS) is included in Figure __ below. The WBS is only expanded to level three and the tasks are included in the project master schedule. A more detailed version of the WBS is provided in Appendix --.

Insert diagram

1.1.4. Contracting Strategy

1.1.4.1. Project Team – Consultants

The execution of the project will be conducted through the appointment of a project manager and engineering services disciplines providing the necessary expertise and capability to successfully execute the project. The project manager will integrate with the client owner's team via the appointed project officer to provide a fully functional Project Management and engineering discipline specialist capability that will define the required standards for project delivery.

The project officer will provide documentation, guidance and metrics on the practice of project management and execution, while adhering to the principles, in specific to industry-standard methodologies as outlined in PMBOK. The project manager's mandate

is to oversee delivery of the project within the defined scope of this bulk infrastructure project. The project manager will enhance and empower the owners' representation.

The project manager and engineering services contract consists of:

- Necessary design work to be executed by the appointed engineering discipline specialists and the timeous completion of designs and 'approved for construction drawings' before tenders are issued. The project officer will also ensure that project scope, time or cost changes are tightly controlled.
- The preparation of the budget cost estimate and the estimated duration or schedule will be executed the project manager that continuously verifies estimates and schedules, and will implement a suitable project control system.
- All construction works to be executed through the project manager's appointed team and will report into the project officer and their team to enable integration between construction works and engineering works. The scope of the construction works contractor services are as per the relevant contractual documentation.
- Contracts will be concluded directly between the project officer (client) and various contractors with the project manager's team managing the procurement process and administration of the contractors in conjunction with the owner's team. The project manager's team is therefore responsible for quality assurance of tender documentation; however the owner's team retains control of any delegation of authority to the project manager and team to ensure that contracts are executed according to the **FIDIC** (Engineering contracts).

1.1.4.2. Roles and Responsibilities of key Project Team Members

The Project manager will have:

- End-to-end accountability for the project and overall execution strategy.
- Full overview over the project team and is responsible for defining their roles and responsibilities within the project, setting their targets and goals, evaluating their performance, monitoring their progress in terms of the agreed deliverable schedules.
- Full authority to set project-wide priorities and goals.

The Project manager's accountabilities will include the following:

- Comprehensive overall responsibility for project management of the work packages.
- Monitoring and control of costs, schedule, technical issues, project priorities, and undertaking appropriate actions.
- Management of the project team resources and monitoring project activities.
- Track and measure overall project progress.
- Track and measure overall project risk.
- Reporting to project officer, project sponsor and stakeholders on project and status.
- Schedule interactions with project sponsor, stakeholders and steering Committee.

- Communicate with stakeholders.

The responsibilities of the Project Officer are as follows:

- Define the user requirements, identified as the ORS (Owner Requirement Specification).
- Integrate solution to align with the agreed operational philosophy.
- Sign-off detail design.
- Provide operations, maintenance and commissioning resources to the project team and manage interfaces with existing operations and logistics.
- Perform a project accounting function regarding maintenance of fixed asset register, system clean-up, contingency management.
- Oversee health and safety management
- Obtain land approvals and conduct purchase including registration of required servitudes.
- Perform risk management.
- Form part of the project team and execute their roles and responsibilities in accordance with the work breakdown structure and approved organogram as depicted under project execution strategy.
- Coordinate and execute the all possible identified project enabling works.

1.1.5. Key Project Objectives

The project objective describes the project's outcomes: intended and direct, short, medium-term and long-term effects on Manguang Metro Municipalities bulk water supply and sanitation services. The project objective lies within the scope of the project, and one must be able to directly attribute the effects to the project.
The key project objective for Mangaung Metro Municipality is to provide sufficient capacity in support of the company's strategic plan to provide bulk water supply and sanitation for the coming years to support the indicated economic growth and increased growth consumption in the bulk services within the next five years at a consistent quality.

- Reduction of losses
- Reduce capacity constraints
- Maximise availability and efficiencies

The key project objectives (desired outcome), are to be identified and agreed with the Client during the project alignment sessions.

1.1.6. Unique Features of the Project

1.1.6.1 Publicity/Confidentiality

All data, reports, records and other information of any kind developed or acquired by any party in connection with this project, shall be treated by parties as **confidential**, and no party shall reveal such information to third parties without prior consent of the other party.

Announcements - The Parties:

- shall consult Mangaung Metro Municipality before issuing any press release or otherwise making any public statements with respect to this agreement;
- shall not issue any such press release or make any such public statement without the prior consent of the other party, which consent shall not be unreasonably withheld or delayed;
- may not, without the prior consent of the other party, issue such press release or make such public statement as may be required by law or a court order.

1.1.7. Major Milestones and Target Dates

Insert Milestones

1.1.8. Risk Management

An Informal risk review has been conducted during the planning and execution stage of feasibility, however formal risk reviews at defined intervals, will be conducted and the findings will be minuted, noted and recorded in the project risk register.

1.1.8.1 Methodology

Risk management will be conducted according to the requirements of the Mangaung metro municipality or at a minimum of the Bigen Africa Risk management process defined in the Rubix© project management governance framework which describes the risk management methodology to be adopted by the client and project manager in accordance with the **ISO 31000:2009** Risk Management Standard as per Figure __ below.

Alignment of the risk management standards between key project stakeholders has been undertaken as required and the risk management plan issued.

Risk Management Policy

In the absence of a client risk management policy, the principals of ISO31000:2009 and the Bigen Africa governance framework will be implemented and adhered to. The process is outlined in this document.

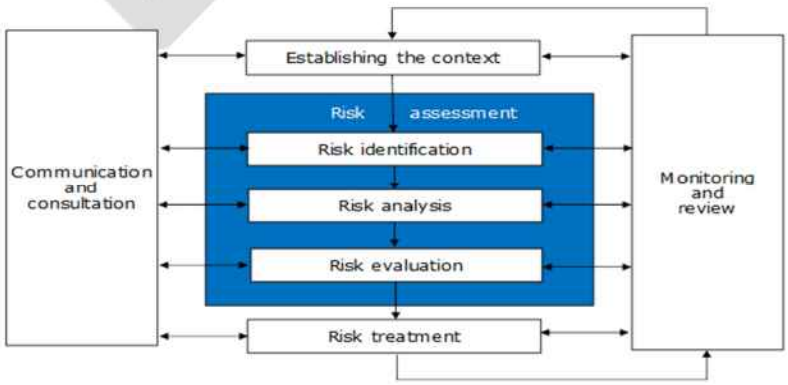


Figure __: Source: ISO 31000 Risk management — Principles and guidelines on implementation.

The Scope of the risk management activities includes:

- Quantitative Risk Review:
  - Project Risk Workshop
- Quantitative Risk Analysis (QRA)
  - CBE QRA
  - Definitive Estimate QRA
- Technical Risk Management
  - Hazop 3
  - Hazop 4
  - Hazop 5
  - Hazop 6
- Risk treatment to support the acceptable level of risk as specified by the project stakeholders.

1.1.8.2. Roles and Responsibilities

The following roles were identified as part of the risk management team:

- Project Officer
- Project Manager
- Project Engineering Discipline Leads
- Risk Specialist

A risk management team is to be established with representation from each of the project stakeholders, the purpose of the team is to:

- Represent each stakeholder in risk reviews and workshops
- Monitor the risk management process and ensure that it was implemented to the required level of quality
- Ensure integration of ideas and mitigation plans/solutions

The team is to be chaired by an appointed risk specialist from either the client entity or appointed specialist consultant within the project team. The following RACI matrix (Table __) describes the responsibilities and accountabilities

Description	Risk Specialist	Project Officer	Project Manager	Discipline Leads
Development and execution of the project risk management plan	C	R	A	R
Development and execution of the technical risk management plan	C	R	A	R

Workshop Facilitation: Project Risk CAPEX and Schedule Technical (Hazard Studies)	 C R I	 R R R	 A A A	 R C R
Risk profile (updating and reporting)	I	R	A	R
Risk register stakeholder communication	I	R	R	C
Project Risk reports	I	R	A	R
Technical risk reports	I	R	A	R

Table __: RACI Matrix

1.1.8.3. Scoring and Interpretation

- ***Qualitative Risk Reviews (QRR):***

  A qualitative risk review has been conducted utilising a recommended 5X5 Matrix relating to Probability and Consequence to rank identified risks for the project.
  The major project risks and mitigation strategies are detailed in a project risk register.

The top ten (10) headline risks based on initial assessment of the project risks are as follows in order of severity:

Risk No.	Risk Event
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Table __: Top Ten Headline Risks

- ***Quantitative Risk Analysis (QRA):***

  A Quantitative cost risk analysis is recommended to be conducted in association with the schedule analysis by determining the potential delays due to risks that would increase costs and modelling the resultant cost impact.

- ***Technical Risk Management (TRM):***
  Hazop 3, 4 and 5 studies are to be conducted at the completion of the designs to identify hazard and operability problems, which could originate from deviations from the design intent

1.1.8.4. Open Issues and Pending Decisions

Insert text – Funding?

1.2. PROJECT INITIATION

This section outlines the project initiation process by briefly setting out the processes by which implementation objectives will be achieved.
Where a document, management plan or other information is earmarked for specific review, it will be provided in an annexure appended to the PEP to confirm its status as ready for review, or be specifically included in an Appended index of existing business system documents.

1.2.1. Kick-off Meeting

This meeting will be set-up within the first two (2) weeks after the project manager's appointment. The following documents/procedures will be presented and approved by parties in order to seek alignment for the successful execution of the project.

- Design Criteria Review
- Project procedures Review
- Project Systems and Administration Reviews

The kick-off meeting will be held in Bloemfontein. The detail of this meeting will be documented and issued as minutes.

The agenda will include:

- Introduction of team members
- Scope setting as per project objectives and scope document
- Role and responsibility discussion
- Project processes and procedures
- Project timeline
- Project Order of Magnitude Estimate (OME)
- Procurement strategy
- Construction strategy

An attendance register will be signed and relevant contact details exchanged.

1.2.1.1. Design Criteria Review (Including Site Factors)

The current process engineering design criteria document will need to be issued by the client to the relevant parties for approval as soon as possible to gain momentum.

1.2.1.2. Project Procedures Review

The project management team will review all the current project procedures required to be drafted and used as part of the implementation phase. The team will be asked to approve and recommend any additional requirements to be actioned. A close review of client organisation defined procedures will also be undertaken to ensure conformance and any deviation from approved procedure.

1.2.1.3. Project Systems and Administration Reviews

The project will make use of the all existing IM systems within the MMM organisation alternatively, Bigen Africa Services will provide a system for approval.
All governance policy and requirements will take precedence and will be applicable with exception of the approved Delegation of Authority (Delegation of Authority to be attached to PEP).

1.2.2. Alignment

An internal alignment session has been held with the project team. This planning session was conducted prior to meeting with the client project officer and their team and referred to as a preliminary project meeting. The objective is to formulate the strategy for execution of the project. The project requirements checklists and the discipline internal audit will be reviewed during the meeting. Activities which may improve the project cost or schedule will be investigated during the preliminary project meeting. Examples of such activities include:

- Incorporating ideas generated from constructability reviews in the design process.
- Using existing data from previous, similar projects.
- Using standard commercial items, systems, or equipment

The objective is to clarify execution strategy, share project values, clarify roles and responsibilities, identify critical activities, align Scope of Work, budgets, deliverables and work processes.

A client alignment session will be held, including information gathering visits to the site as appropriate, prior to the start of the project. The deliverables from these sessions include the key project requirements (also called Key Performance Indicators or KPI's). At the end of the alignment session with the client, all parties should fully understand the project scope. All alignment sessions will be documented by the project manager – Bigen Africa Services.

1.2.3. Activity Plans

activity plans will be compiled by the project manager and issued to the discipline leads of the identified work stream areas of the project, the discipline leads will then be asked to validate the activity plans and confirm requirements which outlined the anticipated activities expected for the project, the procedures to be used to perform the activities and the individuals responsible for preparation, checking / review and approval.

1.3. PROJECT EXECUTION APPROACH

A methodology statement will need to be defined in association with the appointed contractors and will be included into the PEP during the execution stage of implementation. Under this approach, the project manager and engineering discipline leads with the client will finalise the design, defined procurement of all materials, the management of the construction works and management of all equipment installations. All contracts for construction and installations will be held by the client – Mangaung Metro Municipality (MMM).

1.3.1 Execution Strategy

The project is classified as a project that exhibits high complexity and high value and therefore prescribes to the definition of a Mega-project. The project is currently in the execution stage of feasibility. The project approach includes for the design, construction and installation works to meet the needs of the greater Mangaung Metro Municipality bulk water and sanitation supply in accordance to medium and long term requirements capacity requirements. All construction, services and equipment installation activities are due to reach completion and the commissioning during the **second (Q2) quarter of 2021**.

The capacity project will be implemented over a number of separate defined construction areas identified within the overall geographic plan and relate to the specific areas of the existing plant and infrastructure as well as new plants and infrastructure.

This will necessitate the simultaneous establishment of multiple work fronts due to the benefits of fast tracking project delivery by performing construction activities in parallel and this project is heavily schedule driven.
The various work packages will be predominantly grouped together due to similarity in requirements. The principle has been adopted in the grouping of certain packages to facilitate improved management of the overall project and to spread risk more evenly between the client and its contractors.

A principal contractor is authorised to have management or control of a specific workplace and to discharge the duties of a principal contractor, the company so engaged is the principal contractor for the construction work and will be responsible for the appointed specialist sub-contractors appointed to a specific project area or work front.
The role of the principal contractor is to properly plan, manage and co-ordinate work during the construction phase in order to ensure that the risks are properly controlled. A Principal Contractor must:

- manage the health and safety issues likely to be involved in construction,
- the construction phase is properly planned, managed, monitored and resourced,
- provide a suitable health and safety management plan before construction and keeps it up to date as the project progresses,
- ensure that every sub-contractor or contractor is informed of the minimum amount of time which they will be allowed for planning and preparation before they begin work on site,
- ensure that all sub-contractors and contractors are promptly provided with all the information about the project that they need to enable them to carry out their work safely,
- ensure co-ordination and co-operation between sub-contractors and contractors,
- comply with the statutory and regulatory requirements,
- where required, report incidents,
- ensure that clients are aware of their duties,
- take reasonable steps to prevent unauthorised access to the site,
- prepare and enforce site rules,
- provide copies of, or access to, relevant parts of the safety and health management plan and other information to sub-contractors in time for them to plan their work,
- provide workers under their control with any necessary information - this includes the relevant aspects of other sub-contractors and contractors' work, a full site induction and procedures for reporting problems and responding in an emergency
- liaise with the relevant discipline leads on design carried out during the construction phase,
- provide the project manager promptly with information for the health and safety file,
- ensure that all the workers have been provided with a suitable health and safety induction, information and training,
- ensure that the workforce is consulted about health and safety matters, and;
- display the project notification and all statutory appointments

Construction related packages have been grouped together by the identified geographic areas of the project into a single work packages to be executed under a principal contractor. The following disciplines are included in under the direction of a principal construction contractor:

- Earthworks and Civils,
- structural,

- building works,
- electrical/energy,
- mechanical,
- pipelines
- pump stations
- sewer treatment works
- automation, PLC's MCC's
- telemetric & communications

The project structure to be followed during the implementation phase will consist of a project team consisting of the project manager and Discipline Leads, Sponsor and Project officer and the respective project owners and are responsible for the day to day management of the project.

The project governance role will be performed by project assurance within the steercom.
The project team will include representation from the owner's team to ensure complete integration and buy in as well as various consultants under the umbrella of the project management organisation and contractor's team.
The project will comply with all relevant legislation. The project will also make use of the client's emergency response policies, behavioural codes and procedures. The project leadership embraces employment equity as a business imperative and part of the client's management functions and identified transformational responsibilities as stated in the employment equity policy statement.
The guiding philosophy for construction is to minimise the safety risks and optimise the various construction logistics.

1.3.1.1. The Project Manager:

Bigen Africa will be mandated to do the overall project management, project controls, project specific stakeholder management, scope and technical reviews, project integrations and interface management. Furthermore, the teams shall be resourced to review and evaluate claims and compensation events arising from construction contractors. The project team shall also provide a governance firewall and protect the interests of Mangaung Metro Municipality. Required discipline leads will be tasked to do engineering designs and the fulfilment of contractual obligations, agreements and procurement.

- The project structure is shown in Figure __.
- The main purpose of the discipline leads will be to ensure all relevant Mangaung Metro Municipality specifications and procedures are followed.

The full project organisation structure and roles and responsibilities will be discussed in more detail in Section 1.3.4.

The team will include representation from the respective operational teams to assist in the review and approval of all designs.

The review responsibility requires input regarding safety, safe operations, practical layout, maintainability, and learning's from the current operations units within Mangaung Metro Municipality and hence the team will include representation from the respective operational teams.

1.3.1.2. Project Site Offices

Various geographically located project site offices will be established for the staff of the contractors who will be based on site. The position of the site offices are to be finalised between the contractors and the client.

1.3.2. Project Organisation and Staffing

The execution of the project is overseen by the Project Manager and supported by an integrated organisational team and executed through the appointed construction and equipment contractors.

Insert organogram

Figure __: Project Governance Structure

The operational readiness plans will be prepared by Bigen Africa and Mangaung Metro Municipality to ensure that all project interdependencies are identified and monitored through various project owners.

1.3.3. Project Execution - Interfaces

The respective organisational interfaces are detailed in the PEP document. The various required interfaces will are defined by the project RACI (to be compiled) and will play a critical function within the project execution to manage, monitor and control the various dependencies and constraints that exist during the construction and commissioning of this project. The organisational diagrams are intended to merely validate interfaces with various areas within the client organisations that will be required to contribute to this project and are defined expressly as not a function of the overall project execution team dedicated to the execution of the implementation phase. The identified project manager will remain accountable for sourcing of required inputs from the various interfaces within the client organisation.

1.3.4. Roles and Responsibilities

Mangaung Metro Municipality is mandated to take overall responsibility in the role of a governance body ensuring the different engineering specifications from group are applied and managed.
The responsibility chart will be used throughout the project for any communication and approval requirements regarding documentation and project related approvals. The only exception is the delegation of authority matrix related to project approvals.
To enable the execution of the project funds approval process without possible approval delays, the delegation of authority is a framework approved by Mangaung Metro Municipality and provides a clear guideline as to the limits and levels of authority granted for this specific project.
The following Legend applies to the delegation of authority:

D = Develop
C = Consult (Prior)
I = Inform
R = Recommend
PA = Recommend/Prior Approval
A = Approve

In general the following roles and responsibilities of the contracting parties will be as defined below:

- place contracts,
- approve access to the site for contractors and sub-contractors,
- payment of the contractor based on milestone payments, and;
- arrange the supply of utilities (construction power and water) to the contractors as defined

All deviations from the standards are to be documented.

1.3.5. Project Team

The project officer in consultation with the project manager will approve the project team discipline leads. The project organogram as described in section 1.3.2 will reflect the staffing arrangements of the project. The project team will be capable of effective execution of the project.

Insert organogram

Figure __: Outline of Project Team

Where additional resources are required the project manager will notify the project team timeously ensuring that the project delivers on all the key performance areas.

The Bigen Africa and the client's organisation will in addition undertake or directly manage the non-construction packages.

1.3.5.1. The Project Staffing

The project team will consist of the following staffing of the project and will be determined by contractual requirements.

ROLE	KEY ACCOUNTABILITY
Project Manager	Accountable to manage and deliver the project's results and objectives. To establish and direct appropriate governance practices standardised project development and management processes, procedures and tools for the delivery of projects.
Engineering Manager/s	Actively manage engineering deliverables within the Instrument process and Control engineering team supporting Operations. Fully participate in centrally run work planning and execution processes. Participate in HAZOP's as required Maintain technical integrity through implementation and commissioning and work closely with contractors.
Quantity Surveyor	To perform reliable and accurate cost control and reporting, assure financial and accounting operations during all phases of a project, perform accurate cost and budget analysis, forecasting, monthly reporting, auditing and related processes. To ensure that all procurement events for the project follow the agreed procurement plan. To provide procurement-related support to the project team.
Civil & Structural Engineers	The Civil and Structural engineer is responsible for designing structures that are safe and capable of withstanding the elements to which they will be exposed. Preparation of reports, designs and drawings. Making calculations about loads, stresses and selecting appropriate construction materials. Provide technical advice. Obtain planning and/or building regulations approval. Monitoring and inspecting work undertaken by contractors and inspecting properties to check conditions/foundations.
Electrical Engineers	The Electrical Engineer is responsible for the design of all electrical aspects of the project. The Engineer will develop required project specifications with the client. Ensure that designs and installations are reliable and will perform consistently in specified operating environments. Provide supervision to projects and assist with the design of the new production processes. Detail specifications and outline designs. Consider the implication of issues such as cost, safety and time constraints. Monitor installation and commissioning of systems relating to electrical systems.
Health and Safety Manager	The health and safety manager is responsible to coordinate health and safety systems in an organisation. Identify hazards, assess risks to health and safety, put appropriate safety controls in place and provide advice about accident prevention and occupational health to management and contractors.
Document Control Officer	To ensure project documents are updated, latest versions available and information readily available.

ROLE	KEY ACCOUNTABILITY
Risk Manager	To develop and maintain a project risk management framework while providing risk management support to all projects to ensure correct risk structuring. This would include guiding and assisting projects to develop and execute risk management plans, risk registers, risk reporting and communication.

Table __: Identified positions

1.3.5.2. The Contractors (Principal)

The Main Works Contractors will consist of the following minimum management staffing of the project and will be determined by contractual requirements (to be further detailed when contract or is appointed)

Note: Structure to depend on the contracting plan of the project

Role	Responsibility
Contracts Manager	Manages the placement of Contractor and sub-consultant orders and contracts.
Quantity Surveyor/Estimator	Responsible for confirming materials quantities and measurement of construction work, materials on site and orders. Monthly generation of certificates and finalization with the Client appointed QS.
Site Agent / Construction Manager	Manages the construction on site for the complete civils, structural, electrical, mechanical and building work package. Has Clerk of Works reporting to him. Manages, on site, and interfaces with Contractors and is responsible for all site staff based on site within area of work.
Civils Supervisor	Responsible for the execution of all the Civils Works packages. Responsible for managing the contract of the relevant package and supervising the works. Responsible for the setting out and management of labour to execute the planned work on site. Physically check all work prior to inspection for quality and correctness to issued drawings. Identify any issues with designs and liaise with the relevant discipline lead to resolve through the issue of a site instruction.
Building Supervisor	Responsible for the execution of all the Building Works packages. Responsible for managing the contract of the relevant package and supervising the works. Responsible for the setting out and management of labour to execute the planned work on site. Physically check all work prior to inspection for quality and correctness to issued drawings. Identify any issues with designs and liaise with the relevant discipline lead to resolve through the issue of a site instruction.
Purchaser	Responsible for all materials purchases on the site and consumables.
Clerk of Works	Responsible for ensuring consistency of construction approach and defining appropriate construction procedures. Responsible for receiving and issuing the construction drawings as well and managing the stores on site and materials issued. The Clerk of works will maintain the site diary.

Role	Responsibility
Health & Safety Officer	Manages the Health, Safety and Environment issues on site. Safety officers.
Services Commissioning Manager	Manages the testing and commissioning responsibilities. Liaison between the Client and Contractor. This position would commence towards the end of the project.
Quality Manager	Manages the Quality Control on site.

Table __: Proposed Principal Contractor Positions

1.3.6. Team Development

Staff will be employed and assigned to the project or operation as and when required through their organisations, and will undergo the required project inductions prior to commencing work.

1.4. SAFETY, HEALTH AND ENVIRONMENTAL

1.4.1. General Safety Management

The major need for instituting safe working procedures is to avoid personal injury and consequential suffering reference is given to the organisational SHE policy health & safety/ policies & procedures.

The project requires safety to be regarded as a prerequisite of all company operations and will be demonstrated at all times. As such it is the policy to develop and maintain a safe and healthy working environment not only to comply with safety, health and welfare measures required by legislation, but also because of the need to act responsibly to prevent injury, ill health, damage and loss arising from its operation.

This section sets out the responsibilities, processes and methods that will be complied with to ensure the pro-active management of occupational health, safety and environment on the project and has developed this project occupational health and safety management plan on the following four safety principals:

- All incidents are preventable
- Visible leadership is imperative at all levels
- Sound non-negotiable world class procedures and standards
- Zero tolerance for unsafe conditions or behaviours

The Mangaung Metro Municipality, occupational health and the fatal risk standards are the health and safety drivers on the project and all are required to be conversant with the contents and intent of these documents.

Health and safety success is built on attitude and the project team firmly believes that with the right attitude “zero harm” is achievable on the project.

Creating the promotion of safety health and welfare to be an essential component of responsible management has its driving force the creation of an environment in which the achievement of "zero harm" is not only possible but very real.
Occupational health and safety issues will be managed in accordance with all Mangaung Metro Municipalities requirements with special reference to the occupational health and safety management plans prepared for this project.

1.4.2. Project Safety

General safety procedures as issued by Mangaung Metro Municipality will be adhered to and include the following principle rules applicable to the office environment.
Travel safety rules will apply with emphasis on safety at all times. Project meetings will be arranged such that travel after sunset is not required.
Design safety HAZOPS and ongoing risk assessments will be applied to the project. The project safety manager will be responsible for implementing and reporting of all safety related issues.
Full or part-time site safety officers will be appointed reporting directly to the construction managers.
In addition, registered safety officers will be appointed for all the project sites (fronts).

The duties of the client safety officer will be to:

- Assist the contractor safety officers with the implementation of S&H rules for the management of contractors and ensure compliance before work commences.
- Ensure the implementation and compliance with Mangaung Metro Municipality safety rules.
- Conduct project specific inductions on site safety rules for all employees on the sites.
- Ensure that only competent supervisors, skilled people and artisans are working on sites, by collecting up to date job categories and competency requirements with documented proof of training, submitted prior to project specific induction by each contractor.
- Conduct regular safety meetings, to recap on previous activities and plan ahead with the contractor safety officers.
- Ensure the contractors supervisors are reporting and rectifying at-risk behaviours.
- Analyse at-risk behaviours and report back on trends and recommended action plans at the scheduled safety meetings.
- Promote a culture in which safety is the prime concern and will never be compromised.
- Promote the involvement of all employees in improving safety.
- Focus on the elimination of unsafe acts, and rectify unsafe conditions quickly.
- Ensure self and others safety awareness at all times.
- Participate in accident /incident investigations.

- Ensuring that all involved personnel prior to commencement of any work complete risk assessments or safety task instructions (STI). Then, by a review process, verifying that the development process is appropriate, communicated and understood by the users and subsequently complied with.
- Coordinate the risk assessment process, sign and approve all risk assessments, submit to the construction managers for final approval.
- Ensure that all incidents are thoroughly investigated to avoid re-occurrence.
- Complete an incident report for all serious incidents and injuries, including first aid, medical treatment injuries and LTI's. Submit the incident report before the end of shift and or first thing at start of shift.
- LTI's and or potential LTI's must be reported immediately.
- Conduct safety audits.
- Identify hazards and risks through analysis and inspection, including personnel, plant and environment.
- Focus on the elimination of unsafe acts, and rectify unsafe conditions quickly.
- Conduct workplace inspections.
- Approve all contractors' health and safety management plans.
- Co-ordinate the preparation of emergency response plans.

The duties of the contractor's safety officers will be:

- The Contractor shall establish and maintain, and ensure that all his sub-contractors establish and maintain safety, health and environmental standards and systems as necessary, and to comply with local laws, the countries occupational health & safety act & regulations and Mangaung Metro Municipality occupational health & safety requirements under the contract.
- The contractors shall be solely responsible for carrying out the work under the contract, having the highest regard for the safety of his employees, those of the employer and persons at or in the vicinity of all the sites, as well as the safety of the Works, temporary work, materials and the property of third parties.

1.4.3. Tools and Techniques to be used

1.4.3.1. Induction Programme

Before commencing work, all employees to the Project are required to participate in an occupational health and safety induction program. In addition to covering essential aspects of general occupational health, safety and environment issues, the project team shall engender a cultural philosophy of positive attitude, commitment and ownership. The induction will cover items of general occupational health, safety and environment issues and will include but not be restricted to:

- work Permits,
- housekeeping,

- potential hazards,
- personal protective equipment (PPE),
- accident/incident reporting,
- alcohol and drugs,
- emergency procedures,
- specific site safe work practices and procedures,
- project contractor safety regulations and emergency procedures,
- occupational health, safety and environment management plan, and;
- an overview of contract work, methodology and potential hazardous operations

The occupational health, safety and environment induction program is competency based requiring all participants to complete a site specific questionnaire at the completion of the program to ensure that all of the key elements have been understood by the employee. A refresher induction program is considered essential to continually enhance awareness of the project occupational health, safety and environment requirements and is conducted at the end of each twelve months service of the employee.

1.4.3.2. Safety Related Procedures

The following procedures will be used in the implementation phase of the project and is in line with the procedures used within Mangaung Metro Municipality.
There are two site permit access procedures that could apply to a contractor:

1. Work activities on sites with a duration below seven days
   A defined procedure will be followed including the relevant documentation as indicated and will follow the 'production, plant wide and services' route.
2. Work activities longer than seven days
   a) Site access and establishment
   b) Work in progress

To be able to gain access for work that will take longer than the seven day period a full medical examination process and access card permitting will be followed as per the Mangaung Metro Municipality site permitting standard.

1.4.3.3. Visitor site entry

The following procedure will apply with relation to any person not permanently working on the project sites, wishing to visit the sites for whatever reason, may it be from the operational personnel or from the organisations offices:

- Visitors to report to the construction managers site office.
- The safety officer will take the visitor through the site specific safety induction training.
- The visitor will sign in on the visitor's register and receive a site visitor permit card.

- The site safety officer will provide the visitor with the compulsory PPE in the case where the visitor is not in possession of the correct PPE.
- The visitor will accompanied to the area of construction.
- The site manager will upon arrival at the site entrance control point discuss the site related hazard identification instruction and let the visitor sign as acknowledgement of the discussion.
- The person will be escorted till the end of the visit at which point the PPE and visitor permit card is returned.

1.4.3.4. Occupational Health and Safety Training

Supervisors have a responsibility for the prevention of injury, not because it has been arbitrarily assigned to them but because accident prevention and productivity are closely associated supervisor functions. The most direct and consistent method to develop the desired attitudes and commitment and to impart all of the necessary information about occupational health, safety and environment to supervisors is to provide instruction training.

The training to the project team will include:

- firefighting, and;
- occupational health training on how to identify risks as well as prevention and implementation plan

1.4.3.5. Job Safety Analysis

Performing a job safety analysis (JSA) is one of the most powerful tools available for identifying safety needs and requirements. Whilst most hazards are identified after an earlier accident, mistake or omission, a safety analysis examines the safety needs and requirements in a proactive manner. The fundamental importance of a job safety analysis program is that the analysis is conducted prior to the work commencing by the project safety officer in the job planning stages, so as to enable any identified hazards or risks to be engineered out of the job scope.

It is not uncommon that at some stages during the job, the scope of work will change to some degree. When this occurs, the original job safety analysis needs to be reviewed and appropriate alterations implemented by the construction manager/site agent.

The job safety analysis system commences with the breaking down of an individuals or work groups job operations into various stages or units, sufficiently to identify any hazards or risks. This enables a planned preventive approach prior to work starting. For the project a JSA must be completed for each task that is considered by the construction manager/site agent and/or the person/s performing the work to be potentially hazardous or has a particular element of risk.

Examples of tasks which may require a job safety analysis are:-

- heavy lifts,
- working at heights (where there is no work platform),
- spading/blinding,

- tie-ins,
- confined space entry,
- new or infrequently performed tasks, and;
- any task with a high accident potential

1.4.3.6. Fire Prevention

Prior to starting any hot work process the team will undertake an analysis of all possible fire hazards. Where combustible materials are found within the vicinity of the hot work area suitable protection is to be provided to prevent an uncontrolled situation. All hot work areas will have within easy reach, a suitable fire extinguisher, readily available for use. Fire extinguishers will also be provided in all offices, rooms, workshops and stores areas. In addition, all items of mobile plant or other designated equipment will be provided with a suitable fire extinguisher. All such fire extinguishers are to be inspected on a monthly basis, along with the required statutory bi-annual service.

All flammable and combustible materials are to be stored and handled with due regard to their fire characteristics. Flammable liquids are to be stored in approved containers, in an approved flammable liquids storage area. Flammable and compress gasses are to be stored in an isolated area and segregated according to their hazardous goods class with fuel gas separated by a minimum distance of 6 metres.

1.4.3.7. Toolbox Meetings

Toolbox meetings are the means of communicating the occupational health, safety and environment attitude to all employees. The aim of these meetings is for the supervisor to explain and discuss occupational health, safety and environment related subjects and problems in a clear and concise manner so as to ensure understanding by all participants. To achieve this aim it is important to create an interest in the subject and a desire to learn because of the practical value to each employee.

The short duration talks are based on material supplied by the occupational health, safety and environment departments, or alternatively may centre on a particular accident/incident report. The talks are intended to discuss occupational health, safety and environment issues in a constructive fashion and not to conduct a fault finding or complaining exercise. Suggestions by all participants are to be actively encouraged.

1.4.3.8. Job Start Talks

Job start meetings shall be conducted each morning by the supervisor with his own crew. The format is to discuss the activities/tasks to be carried out for the day ahead. The construction manager/site agent will not only discuss the technical aspects of the work but also what occupational health, safety and environment hazards which may exist and what precautions the crew should take to prevent incidences or injury.

1.4.3.9. Workplace Inspections

The principle objective of work place inspections is to detect and eliminate unsafe acts, practices and conditions in the workplace before they can cause injury. Whilst Inspections provide the vehicle for systematic periodical checks they also provide a number of additional benefits. They have an effect on communication in a work area, help to improve and facilitate industrial relations and enable employees through the occupational health, safety and environment representatives to play a greater role in the maintenance of a safe working environment through participation.

Routine regular Inspections shall be performed by elected occupational health and safety representatives and officers, and will be scheduled so that results can be reviewed regularly by management. Significant performance improvement can be achieved simply by establishing a programme of safety inspections and acting on the results obtained. Feedbacks of the results of inspections to the managers of the areas inspected are an essential part of the inspection process.

Inspections shall be conducted regularly and shall be principally the responsibility of the project manager or delegated to the appointed officers, the occupational health, safety and environment advisers and nominated occupational health, safety and environment representatives.

1.4.3.10. Occupational Health and Safety Audits

All Occupational Health, Safety and Environment Legislation, under which the project performs work imposes the obligation of “duty of care” on employers, employees and others.
“Duty of care” is a broad concept which essentially requires all reasonable and practicable action:

- employers that will ensure the health and safety of employees at work,
- employers to ensure the health and safety of persons not in their employment and member of the public (i.e. subcontractors and visitors), and;
- persons in control of workplaces used by non-employees to ensure their health and safety on the project sites

1.4.4. Occupational Health Management

Occupational health management includes the following:

- hazard register,
- risk assessment,
- principle hazard register,
- critical control register,

- legal and standards review,
- management strategy and plan,
- stakeholder assessment,
- implementation plan, and;
- resource requirement

The site safety officer will fulfil the position of the occupational health officer and is included in the planned training.

The principal contractors project safety plans are to be provided prior to commencing construction works on the sites.

1.4.5. Security Management

The requirements in terms of security are to be developed in terms of the health, safety and security management plan for the various and specific geographically located and remote sites. Security is of high importance to the success of this project.

1.4.6. Emergency Response

Emergency response plans will be prepared for construction, commissioning, and operation on the project before each activity begins. These plans will ensure early notification of any incident.
The principal contractors are to ensure that coordinated plans are prepared by sub-contractors and vendors to cover all activities on the project. These plans will be prepared in consultation with the project manager / project officer / vendors and local emergency services.
Fist aiders are available on site with emergency equipment to deal with minor safety incidents. Local hospitals are available to deal with major incidents

1.4.7. Environmental

1.4.7.1. Purpose

All environmental requirements with respect to the Sites need to be determined during a full ECC process to commence 2015.

1.4.7.2 Scope

The environmental requirements are to be detailed in an environmental management plan annexures:

- Adherence to Standard Environmental Specification (SES) (ENV-STD-002 Rev 01).

- Adherence to Construction Environmental Management Plan (CEMP) ENV-STD-001 Rev 01.
- Project Environmental Specification (PES)
- Conditions as per the RSA Environmental Authorisation & Environmental Compliance Certificate (ECC).
- Produce and implement relevant Method Statements as per the CEMP.
- Provide proof of communication to sub-contractors to comply with these requirements.
- Provide daily, weekly and monthly completed checklists as required.
- Provide organogram of roles and responsibilities of various personnel responsible for environmental management.

1.4.7.3. Controls and Specifications

The construction works of the bulk water supply and sanitation project are within green field and brownfield sites. This means that part of the construction will commence within an area that has not been disturbed previously and will therefore have an impact on the environment (both biophysical and social).

Management plans as developed by the relevant specialist consultants as per the ECC process will be implemented on site.

The plans include:

- Environmental Management Programme (EMPr) – contains recommendations and mitigation and management measures to reduce negative impacts for the construction activities within the borders of South Africa. The EMPr may detail frequency of mitigation measures to be applied as well as the responsible person and associated costs. The format of this document is regulated by the Department of Environmental Affairs (DEA). It will be a condition of the authorisation that the EMPr be implemented.
- Another document that forms part of the Environmental Management Plan is the Project Environmental Specification (PES) which
- Indicates the additional project specific environmental requirements. The PES specifies any conditions and process that are required by the environmental authorisations which are not already covered by the Standard Environmental Specification.

1.4.7.4. Environmentally Sensitive Areas

As mentioned above the bulk water supply and sanitation project will be constructed within some greenfield areas and hence sensitive areas may be impacted. Sensitive areas that will most likely be impacted are wetlands and areas of historical interest.

Environmentally sensitive areas are to be investigated through the process. Specific requirements for the protection / conservation of these areas will be contained in the EA and the Project Environmental Specifications that will consist of the EA requirements and standard CEMP & SES requirements. The PES provides detailed management measures for construction activities required in these areas to ensure its adequate protection / conservation throughout the life cycle of the project.

1.4.7.5. Risks

The environmental risks associated with the construction works associated with the bulk water supply and sanitation project are to be addressed and mitigated through the process. The risk of not being granted environmental authorisation needs to be dealt with extensively by implementing effective public engagements, Authorities engagement as well as sufficient specialist studies to ensure all elements have been covered. Current environmental risk remains obtaining the additional environmental permits such as water use licenses, borrow pit approvals, heritage permits etc. Mitigation measures are to be defined and put in place such as regular engagement with the relevant authorities and grouping of water use licenses.

1.4.7.6. Environmental Licences, Permits and Approvals

The environmental approvals and licences necessary for the project result from the legislative requirements governing South Africa.

This section will detail the required permits and approvals required for the country construction, commissioning and operations. This plan will also detail the strategy and responsibilities for obtaining the relevant licences, permits and approvals.

1.5. QUALITY

1.5.1. Quality Policy

The project quality objectives are to demonstrate ability to supply quality services that meet client and applicable regulatory requirements, and to ensure client satisfaction through effective application of the system, including processes for continual improvement and the prevention of nonconformity.
The project will establish and implement a documented quality management system (QMS) in accordance with the requirements of ISO 9001:2008, to ensure all contract activities are controlled, measured, monitored, analysed and conducted in an effective and systematic manner and meet the client's quality requirements.

Project quality objectives are defined in accordance for the following clauses outlined in ISO 9001:2008:

- The requirements (clause 5.4.1) for quality objectives are:
- Establish quality objectives at relevant functions and levels
- Include objectives to meet product requirements
- Quality objectives must be measurable
- Keep these quality objectives consistent with the quality policy
- Make all personnel aware of the importance of the objectives and how they can help to achieve them (clause 6.2.2d).

The project team is fully committed to complying with the requirements of the QMS and to continually improving the effectiveness of the study and implementation activities.

1.5.2. Quality Management Overview

To successfully meet the quality objectives of satisfying or exceeding the clients' needs and expectations the approach to all the project activities is:

a) the client is always the final judge of the quality of deliverables and services received,
b) total and continuous commitment of management is imperative to the successful implementation of the QMS,
c) The project team and client resources are in the best position to understand and improve the quality of the project's processes,
d) all project processes must be monitored and measured if continual improvement and innovation of all activities is to be achieved.

1.5.3. Quality Planning

Quality Planning activities are to be detailed in a standard QMS procedure. Quality planning relating to project management activities consists of the following:

a) identification of quality requirements for the project,
b) specifying project quality objectives and deliverables related to project quality
c) requirements in a project quality plan,
d) ensuring product quality objectives are identified and specified in documents such as
e) design criteria and contractors quality control plans,
f) identification and provision of applicable resources and information needed to support, and;
g) the project quality plan implementation.

1.5.4. Quality Assurance

Project quality assurance is conducted in accordance with project team quality activities.

Overall performance of the project during implementation will evaluated by QMS audit and surveillance on a regular basis, to provide confidence that the project is meeting the applicable quality standards.

The inputs to perform the quality assurance process are noted as follows:

- *Quality Management Plan*: The quality management plan describes how the process of perform quality assurance will be carried out. Also of interest here is the process improvement plan which details how the work is being performed and what actions might be taken to improve this performance and as such is a key input.

- *Quality metrics:* During the process "plan quality" these were defined describing how quality will be measured and may relate to any aspect of quality. One which is important is that each quality metric must be measurable and so details of the amount and units for each metric must be clarified providing an objective means of measurement.

- *Quality control measurements:* These are an output from the perform quality control process, and consist of important documented measurements of quality levels and compliance. These measurements are derived by inspecting and reviewing all project deliverables to ensure they comply with specifications, as well as coming from potential areas to improve any aspect of the management of the project.

- *Work performance information:* As already stated, perform quality assurance is concerned with process improvement, and so work performance information is an important input as it will assist in identifying areas where process improvements are needed. This input will also include information regarding areas with process improvements have worked. In summary, the purpose here is to fix poor process areas and it knowledge or possibly enhance successful process improvements.

The outputs from the quality assurance process:

- *Change requests*: Since this process carries out analysis and evaluation then it is normal to expect that change requests would be a natural outcome of this process, and as such change requests is the main output. Most change requests from this process would be about procedural changes.

- *Management plan updates*: As a result of this process the way in which the project is being managed is likely to change. Within the project management plan is the quality management plan and the process improvement plan and one or both of these two documents are highly likely to be updated.

- *Project document updates:* Changes to quality can impact just about any element of the project including budget, schedule, scope, risk, resources, etc. So therefore any

particular knowledge area and their related plans may need to be updated as a result of performing this process.

- *Organisational process assets updates:* These consist of any assets which can be used for future projects and as such should be updated whenever such practices are implemented or indeed if any new information has been learned.

The common tools that are to be used for the plan quality process and perform quality control process include, but are not limited to:

- cost benefit analysis,
- process Analysis,
- benchmarking,
- cause and effect diagrams,
- inspections and reviews, and;
- quality audits

These are the primary tools used within quality assurance because such audits review the project in order to evaluate which of those activities being carried out on the project need to be improved, and which of those leads the required quality standards. The objective of these audits is to improve acceptance of the product and to minimise the overall cost of quality.

The project team in conjunction with the project officer will be responsible for the administration of the project quality management system (QMS) and has the responsibility and authority to ensure implementation of the project QMS requirements by the following means within their specialist discipline areas:

- administration of quality assurance, quality control and expediting activities,
- conducting periodic internal QMS audits and surveillances,
- issuing corrective action requests (CAR's), and
- reporting on the effectiveness of the QMS to the project manager

1.5.5. Quality Control and Expediting

The purpose of the project quality management plan (QMP) is to document how quality management is to be applied to the project, to meet the requirements of ISO 9001:2008 and the client's specific standards, policies & procedures.
The QMP addresses the activities that the project team will perform on the project, including quality planning, quality assurance and quality control to ensure that quality objectives are met during the project.

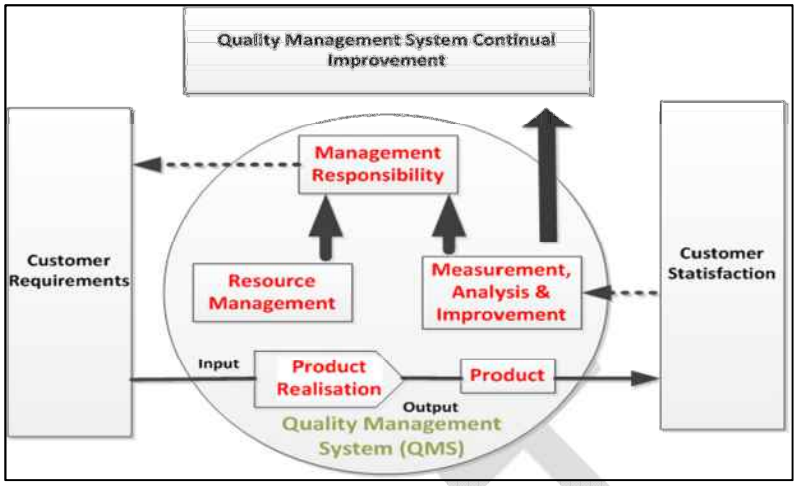


Figure __: ISO 9001:2008 Quality Management System

The project quality management system is a systematic means of achieving project quality objectives which include:

- Identifying the processes needed for the project QMS.
- Managing the sequence and interaction of these processes.
- Documenting the system in accordance with ISO 9001:2008.
- Implementing and improving the system during the project.

The Project team will utilise quality standards and procedures as necessary to control project activities:

- To ensure that a project quality management system including all project procedures is followed with respect to all engineering, procurement, and construction and management activities.
- To identify the quality management standard applicable to, and required for the project, and will document project management commitment to its implementation in a project quality policy.
- Document how quality management is to be applied to the implementation phase of the project to meet the specified quality management standard and client specifications, including applicable activities, procedures, deliverables, documentation and records, in a quality management plan.
- Purchase orders for critical and major material/equipment will require that suppliers (including sub-suppliers) submit quality control plans (QCP) for work to be undertaken, for acceptance by the project team and the client where required prior to work commencing.
- Quality control and expediting services will be conducted in accordance with the requirements of the client's quality management framework (if applicable).

Inspections shall ensure that contractors/vendors/suppliers provide quality control plans specifying the proposed quality control activities for the scope of their supply or contract. These quality control plans shall incorporate, at a minimum, the requirements specified by the specific discipline project engineer. The project shall use the contractors and suppliers quality control plans to control and monitor suppliers quality.

Quality control and expediting shall be carried out for all building, civil, structural, mechanical, services, piping, electrical, and controls and instrumentation equipment and materials procured for and during the Project. The discipline engineers will support this methodology while integrating with the client representative.

1.5.6. Quality Reviews

The responsibilities for quality reviews to be performed on the project are shown below. This includes participation in reviews at suppliers / sub-contractors / site / third party as applicable:

- design & development engineering,
- project documentation quality/project management,
- technical specifications / standards engineering,
- project management review, and;
- drawings / concept drawings / process flow diagrams, etc. engineering

It is noted that reviews are also to be held after any controlled changes being implemented, documents can only be distributed after undergoing formal reviews, independence, objectiveness and integrity must be maintained at all times and records of all reviews must be maintained or as deemed otherwise.

Design peer reviews will be conducted to remove defects as early as possible in the design development process. By removing defects at their origin (e.g., requirements and design documents, test plans and procedures, etc.), design peer reviews prevent defects from propagating through multiple phases and work products, and reduce the overall amount of rework necessary or abortive work on the project.
In addition, improved team efficiency is achieved through design peer reviews (e.g., by improving team communication, integrating the viewpoints of various engineering specialty disciplines, more quickly bringing new members up to speed, and educating project members about effective development practices).
A design peer review is important when:

- Reliable performance is crucial and/or process design lacks redundancy
- Operation is related to health and safety
- Using new technology, process or innovative design

1.5.7. Responsibility, Authority and Communication

Project roles and responsibilities, required for all personnel, including QA/QC personnel, to execute their activities are to be finalised and detailed in the developed project RACI Matrix of implementation phase.

1.5.8. Key Success Criteria

Key success criteria identified are:

- Timeously reporting of incidents affecting quality.
- Timeously reporting of non-compliance with project policy and procedures
- Corrective and preventive action to address non conformities or incidents.
- Adherence to the quality management plan.
- Identification of critical and major components
- Appointment of third party inspection services
- Auditing of contractors activities in accordance with the approved QMS audit schedule.

1.5.9. Design and Development

Design and development activities such as planning, reviews, inputs, outputs, verification and validation are conducted in accordance with the approved employer's procedures. The critical dates in the schedule are the driver for the design work. During the design phases i.e. concept, detailed design and release for construction, the quality assurance activity is to ensure that items presented for review and acceptance comply with the inputs requirements and are sufficiently complete to ensure that the project may proceed to the next stage with minimal risk.

1.5.10. Procurement Quality Management

The procurement operating plan defines the procurement packages applicable to the project. Discipline or professional service providers are required to ensure that kick off meetings are held with the suppliers/contractors so that they are aware of the requirements of the purchase order and the contract conditions. Material / equipment are classified for criticality in accordance with the employer's standards to determine the extent of QCP's and interventions. Inspections are applied to all critical and major material and equipment.

1.5.11. Construction Quality Management

Construction quality management is conducted in accordance with the developed construction manual.

1.6. PROJECT ADMINISTRATION (COMMUNICATIONS MANAGEMENT)

1.6.1. Project Communications

All communication management will be driven by making use of the stakeholder analysis in conjunction with the responsibility matrix. Further acknowledgment is referenced to the Bigen Africa communication management policy and communication management procedure

The project will make use of an issue log register to ensure that all issues are closed out in a timely manner and will be kept up to date by the project manager.

Every person responding adding or responding to an issue will copy the project manager in the mail referring to the issue log number. In the case of a new issue to person should first contact the project manager to obtain an issue log number. The log register will consist of the following sections as seen in Table __ below. Whenever any return mail is send regarding an existing issue log the same log number as before will be used.

Log number	From	To	Discussion	Open / closed

Table __: Issue Log register

1.6.1.1. Project Meetings

The following project meetings will form part of the project team interactions both internal and with the external contractors:

- *Governance roles and responsibilities* (executive board, steering committee, project sponsor).
  A monthly steering committee meeting will be arranged.

- *Fortnightly project team meetings*
  The project team as well as the principal contractors will meet on a fortnightly basis for the purpose of general progress feedback as well as any project related issues that require escalated feedback. The meetings will also provide specific site feedback to the principal contractors with regard to safety, progress, quality etc.
  The meeting is critical to ensure integration between the discipline leads and the principal contractor. The meeting will be chaired by the project manager.

- *Fortnightly project team site progress inspection meeting (walk-about)*
  The project team as well as the principal contractors will conduct a site progress inspection meeting or “walk-about” on a fortnightly basis for the purpose of general progress monitoring as well as any site information related issues that require instruction.
  The site walk-abouts are critical to ensure required instructions are issued timeously to mitigate delays to the works. The site walk-about will be chaired by the

principal contractors designated contracts manager. The walk about will be conducted prior to the bi-weekly project team meeting.

- *Monthly project steering committee meetings*
  The project steering committee will meet on a monthly basis to get feedback from the project manager as well as to supply the project manager with advice and support where required. The steering committee will be chaired by the project sponsor.

- *Monthly Client Meetings*
  As a minimum a monthly meeting with the client will be conducted. This meeting will be used to update the client on project progress and issues.
  A detailed project month report will be issued to the client. In general the cut-off date for the report will be the last Friday of the month. The report will be available by the next Friday.

  The month report will detail the following:
  - project managers overview/executive summary
  - SHE statistics and reports
  - Schedule and progress
  - Cost status report
  - Engineering status/progress
  - Procurement and fabrication status/progress
  - Construction and commissioning activities
  - Areas of concern and corrective action

- *Safety meetings*
  Safety meetings will be conducted as per the safety management plan discussed in Section 1.4.3.

- *Other Meetings identified per Communication Plan:*
  - Expenditure authorisation and expenditure approval requirements
  - Design co-ordination & peer review meetings
  - Key stakeholders meetings
  - Project team co-ordination meetings
  - HAZOP (Hazard Identification and Operability) reviews
  - Performance health checks & reviews.
  - Independent 3rd party reviews

1.6.2. Correspondence

Correspondence of a contractual nature shall be via hard copy, with original signature "wet signature", but may be copied via email to the recipients.
Day to day correspondence shall be via email.

All correspondence will be filed at the project manager's office in hard copy (only contractual documents) and electronic format (all documentation).

1.6.3. Monitoring and Evaluation Plan (Reporting)

The monthly integrated reporting structures exist within the project management office as a final line of reporting. The integrated reporting structure is used to report all information on the current project to the steering committee.
The monthly integrated reporting will be performed by the project manager including the engineering disciplines. costs, schedule, quality control, HR and communication will be reported and information provided at the beginning of each month. A standard one pager A3 reporting dashboard will be used and generated.

In addition to the integrated reporting, the project manager will issue an executive report to the project office, owner and sponsor by no later than the 5th of each following month for the purpose of highlighting any critical issues that needs attention.
The project manager will also at the end of each month, provide the project officer and owner with a project report for the purpose of reporting any issues as well as general progress covering the following sections:

- safety, health and environment,
- engineering,
- schedule,
- quality,
- human resources,
- procurement,
- document control, and;
- general

Safety incidents will be reported by using the relevant reporting mechanisms as referred to in the safety section.

1.6.4. Project Authority Matrix

The project authority matrix is to be finalised by the appointed Steecom and incorporated into the relevant delegation of authority documentation.

1.6.5. Document Approvals.

Please refer to section 1.7.3. Document Control.

1.6.6. Records Management

1.6.6.1. Project Filing System

All filing, electronic and hard copies will be done in the project manager's office and, located at Allan Cormack Street, Innovation Hub. Persequor, Pretoria.
An electronic project directory has been opened by Bigen Africa Services in a dedicated document and drawing control system – **ProjectWise** the required provision of access to the project team will need to the finalised with a secure link accessed through **Project Portfolio Office (PPO)**. All documentation created on the project will be saved in ProjectWise.
Any hard copies of correspondence and documentation created on the project will be scanned and filed as per the electronic directory structure. No hard copies of documents or correspondence will be retained unless documentation is of a legal or contractual nature required to be retained for a period of 5 years post project completion.

1.6.6.2. Filing System

All the original signed drawings, created on the project, will be archived by the project management office, and retained for a period of 5 years.
An electronic copy of all drawings will be issued to the client on completion of the project within the "as-built" handover package.

1.6.6.3. Public Relations

All issues pertaining to public relations are to be addressed through the project officer's office and the project manager.

1.6.7. Legal, Regulatory and Compliance

The nature of this project involves the development of additional capacity for bulk water and sanitation and the applicable country's Acts in respect of legal and regulatory will be applicable based on the various sites regional zoning – Mangaung.
All project related works will be subject to the prevailing and enacted South African legislation.

1.6.7.1. Safety Organisation and Legal Compliance

South Africa demonstrates an approved and enacted legislation with respect to health and safety. The Mangaung Metro Municipality health and safety plan is to be referred to in respect of the legal compliance plan.
The following site appointments are required under the Occupational Health and Safety Amendment Act, No. 85 of 1993 as amended by Occupational Health and Safety Amendment Act, No. 181 of 1993 and the Construction Regulations Act of 2014.
Section 8 of the OHS Act refers: all employers must, where reasonably practicable, provide and maintain a safe, healthy working environment that is without risk to employees.

The person primarily responsible for ensuring a safe and healthy work environment is the chief executive officer or person deemed to be the chief executive officer of the client organisation.
The Act clearly states in section 16 (1) that the chief executive officer may appoint any person under his control to assist him with his functions and responsibilities under the Act, in other words, as part of his OHS Act appointments.
The legal phrase delegatus delegare non protest applies, meaning that a delegate cannot delegate. The right to delegate particular functions falls away after it has been delegated once, and a person can only appoint another if that person is under his/her control and direction.
In terms of section 16 (2), without derogating from his responsibility or liability in terms of subsection (1), a chief executive officer may assign any duty contemplated in the said subsection, to any person under his control, which person shall act subject to the control and directions of the chief executive officer.

Mine Health and Safety Act, 1996 (Act No. 29 of 1996) will provide the legislated foundation with respect to Borrow Pits.

1.6.7.2. Legal Compliance with Legislation

The contractors will ensure that all sub-contractors shall at all times during the continuance of the contract comply with the site health and safety specifications, instructions, procedures and directives directed by Mangaung Metro Municipality.
The contractors will provide and implement adequate occupational health, safety and environment management legal and insurance practices in line with the requirements of Mangaung Metro Municipalities sites where the work is to be conducted.
The contractors shall ensure that all contractors occupational health, safety and environment plans are aligned with the requirements of this standard where ever possible.
The contractors shall be responsible and accountable for public liability and comply with the insurance cover as addressed in the relevant Mangaung Metro Municipality contract.

1.6.7.3. Permitting and Approvals Plan

The project officer and owner will produce a permitting and approvals plan to detail all relevant permits and approvals required for the execution phase.
The permitting and approvals plan will detail the required permits and approvals required for all the sites for construction, commissioning and continuation of operations.

A number of key licences and authorising institutes for the bulk water and sanitation project are illustrated below in Table __.

Regulatory Institution	Key Licences/Approvals

Department of labour	Construction permit
Local municipality/district municipality	Approval of site development plans – town planning. Approval of Building Plans.
Power	Alterations to power demand and new connections.

Table __ Key regulatory institutions and Licenses

1.6.7.4. COID/WC and UIF

The contractors will ensure that all sub-contractors shall be registered with the Unemployment Insurance Fund (UIF) and submit proof of good standing.

The contractors shall, before the commencement with work on site, furnish the project manager with proof of a valid registration through a certificate of good standing in terms of the South African Compensation for Occupational Injuries and Diseases act, (COID Act), 130 of 1993 and that all payments due to the commissioners are discharged. This cover shall remain in force during the contract and shall be the responsibility of the contractors to ensure validity.

The contractors will ensure all sub-contractors submit separate returns of shifts worked by his employees, specifying the names, initials, employee numbers and identification numbers.

1.7. PROJECT CONTROLS

1.7.1. Project Codification

The codification will need to be developed and agreed in accordance to the approved and the project specific Work Breakdown Structure (WBS).

1.7.2. Scheduling

The ownership of the Master Plan/Schedule is that of the project team incorporating the client, consultants, and contractors. The schedule is to form a basis on which to plan design, information flow, procurement of the contractors, approvals, procurement of materials, construction activities, commissioning, operational readiness, ramp-up and completion of the works. Dialogue will be held between client, consultants and various contractors to establish a workable master plan and schedule. All parties will commit to the timing and sequence of the activities they are responsible for as well as signing off and accepting the schedule. This approved schedule will be recorded as the project baseline schedule, and may not under any circumstances be changed. Should the project manager request a schedule revision through an approved change management control procedure, a target schedule will be captured, however the original baseline will remain unchanged for the project duration.

The project manager will co-ordinate the planning and development of the master schedule and to manage, monitor, control and report the achievement of each participant. The objective of the schedule management exercise is to succinctly understand the past and pro-actively plan the future with full buy-in by the project team at each defined progress update. All participants need to provide accurate reports on the achievement against schedule when required to do so.

The estimated high level master schedule is shown in Figure __.

Insert schedule

Figure __: Level 2 Master Schedule

1.7.2.1. Progress Measure Procedure

The critical path method (CPM) technique of planning and scheduling will be used for the project. The project will utilise Microsoft Project ver.2010 or similar software to manage the project schedule on a day-to-day basis.

Schedule management will be conducted by using the integrated detail schedule with the following tools:

- S-curve of planned % progress vs. actual % progress
- RAG indicators on the schedule indicating:
    - white for activities not planned to start yet,
    - green for activities on target or less than 10 working days late,
    - orange for activities less than 20 working days late (recoverable within 1 month), and;
    - red for activities more than 20 days behind planned progress (irrecoverable within 1 month)
- Any change in the critical path or secondary critical path becoming the primary
- Risk of late activities on critical path
- Progress measurements are to be undertaken jointly by the contractors and appointed project manager and agreed to prior to submission of regular progress reports.
- Physical site inspections of the construction works or fabrication works is to be undertaken by the contractors at regular intervals as defined by the project manager and physical progress agreed.

  The following information is to be recorded at each progress measurement interval:
    - actual start date of the planned activity,
    - actual finish date (if complete) of planned activity,
    - percent complete of “in-progress” activities,
    - remaining duration of “in-progress activities”, and;
    - recorded delays to the schedule showing delays in progress measurement interval as well as total cumulative delays
- Progress is to be updated from the individual contractors progress report/schedules into the master schedule by the project manager and presented in a summary joint progress report duly signed off and agreed to by the project manager and the individual contractors.
- The joint progress reports are to be presented to the project office/owner contained within the overall management report as submitted at specified monthly intervals.

The master schedule is attached in appendix __. It should however be noted that the master schedule will be further expanded and detailed to activity level once the contracts have been placed on the relevant service providers and construction teams, and the various detail schedules have been approved.

1.7.2.2. Scheduling of Contract and Sub-Contract Packages

Each contractor shall, within **4-weeks** from date of letter of acceptance/appointment of the tender, submit to the project manger a detailed control level schedule (minimum of Level 3) and supporting documentation for the execution of the contract including the work of all nominated and/or selected sub-contractors, representing the duration of the categories of work in sufficient detail to enable the project manager to assess the progress of works at all times in comparison with the master plan/schedule. This schedule shall be in terms of the accepted preliminary schedule of the successful tenderer which preliminary schedule was submitted with the tender. It is also expected of the contractor to provide a suitably detailed basis of schedule document at the time of submitting the schedule for acceptance and approval.

The contractors shall, when updating the schedule, consult with the nominated and/or selected sub-contractors and other contractors and shall also take cognisance of any procedure of works (phasing) items, were applicable.

The control schedule shall comprise of the following:

- An approved and coded hierarchical work breakdown structure (WBS) conforming to the agreed project WBS and codification, depicting all deliverables and related activities required to formulate the schedule. The deliverables reflected in the WBS shall relate to the billed items and the following details shall be presented:
    - unique activity ID linked to the WBS code by means of a prefix that will be unchanged throughout the project and reflected on all schedule printouts/electronic media,
    - activity description (suitable detailed description which clearly identifies the effort of the activity),
    - responsibility assignment (a clear distinction shall be made between activities relating to the various packages),
    - original activity durations,
    - resource breakdown into responsibility assignment,
    - budgeted costs (applied to hammock activities only referred to in (iii) below),
    - total float for each activity, and;
    - related activity priority or weighting if utilised

- A gantt chart reflecting the structure and details (including agreed codes) of the WBS and following the logic established. The critical path shall be clearly depicted and show the float of non-critical activities. The schedule must be checked in terms of integrity and there shall be no open-ended logic.

- The contractors may not under any circumstance modify, adjust or change approved schedule logic, approved leads, approved lags, original activity durations, and resourcing allocations or associated hammock costs, unless so approved by the project manager and recorded via an approved change management control procedure.

- The use of leads and lags in activity logic shall be restricted/limited to a minimum. Where specific leads and lads are utilised on the critical path activities, the contractor shall rather include a “dummy” activity to indicate the led or lag.

- A linked/integrated project cashflow derived directly from networked cost hammock activities. These hammock activities shall incorporate manageable series of activities and the budget costs assigned to them shall relate directly to the billed items.

- Resource profiles of principal teams and identified responsible persons (degree of resource levelling to be defined by the project manager and agreed) will be included into the schedule and should be derived from the submitted and approved resource plan submitted to the project manager.

- The contractors shall implement their schedule and shall re-schedule the works should the schedule not accurately reflect the extent, procedure and/or progress of the works. The schedule and any subsequent re-scheduling shall be done in conjunction with and agreed to by the project manager via an approved change management control procedure. Copies of each schedule shall be submitted for use by the project manager, nominated and/or selected sub-contractors and other contractors.

On an agreed basis, at a regular date agreed to by the project manager, the project manager shall prepare a progress report including:

- An overall gantt chart depicting current progress against baseline of the master schedule inclusive of all sub-projects.
- A master schedule “S” curve depicting current progress against the baseline and forecast to completion.
- A filtered master schedule gantt chart of the critical path.
- An overall project cash flow depicting the current forecasted cashflow against the baseline cashflow in the form of an “S” Curve.
- A tabular progress report. The format of this report shall be agreed to by the project owner.

All consequences of the relevant clauses relating to time shall be based on the agreed schedule and progress thereof. The submission to the project manager of the schedule(s) and reports shall not relieve any of the contractors of their responsibility to timeously complete the contract. The schedule is deemed to be a contractually binding plan and document.

1.7.3. Document Control

1.7.3.1 Document Management Principles

The Project Team and all its vendors shall apply the following document management principles, unless specifically agreed otherwise in writing with the duly authorised stakeholders:

- Plan each document’s life-cycle the appropriate project schedule(s), this document management procedure and its flow diagram.
- The appropriate project team members should reach consensus on every document before circulating it externally, hence internal reviews are essential.
- The relevant project administrator shall:

- coordinate, register, distribute, store and assure appropriate disposal of all externally distributed documents, both outgoing and incoming within the project, and;
- register and report the relationships between all project related configuration items and documents

- Every project team member shall only use the appropriate revision of a document; either current or as contracted. Should the document user not be certain if they have the correct revision of any particular project document the user should check this with one of the project administrators.

1.7.3.2. Document Management Rules

The following Business Rules shall govern the management of all project documents unless specifically agreed otherwise in writing and with the duly authorised stakeholders:

- Only project documents that are both approved by the applicable signatories, and are recorded in both native and PDF format, shall be considered official project documents.
- A project document shall only be considered approved if all the signatories required to sign-off the document have physically signed the document i.e. the document contains a wet signature for each of the required signatories.
- A delegation of authority for the approval of project documentation shall only be considered valid if:
  - The delegation of authority is confirmed in writing and signed by the appropriate approval authority; and
  - The delegation of authority clearly stipulates the duration (start date and end date) for which this delegation of authority will be valid (up to a maximum of 30 calendar days).
- A delegation of authority for the approval of project documents that stipulates a duration in excess of 30 calendar days, shall only be considered valid if, and only if, it is signed by both the appropriate approval authority as well as the project manager.
- If a project team member has been delegated the authority to approve a project document, a hard copy of this delegation of authority must be included with each project document signed by this team member. Failure to comply with this rule shall automatically render the project team member's signature on the applicable project document, invalid. (This automatically implies that the project document is not approved and may not be distributed as an official project document.)
- "The vendor shall be obligated to only accept and use any project documents that were submitted to them by an authorised project team member, and not any other source. The vendor hereby indemnifies Bigen Africa and Mangaung Metro Municipality and any of its affiliates against any claim, regardless of the nature of the claim that may arise either as a direct or indirect result from the use of a project document that was not submitted to the vendor by an authorised project team member.

- An internally developed project document shall only be allowed to be submitted for external review if the document has successfully passed internal review. This automatically implies that if a draft copy of an internally developed project document is not recorded in the project directory, the document may not be distributed for external review (since no record exists that the document has successfully passed internal review).
- If the author of an internally developed project document submits a document distribution request, but the meta-data of that document is not correct/accurate, or an incorrect template was used to create the document, the project manager shall do the following:
  - reject the project document and notify the author that it has been rejected and the reason why it has been rejected, and;
  - create a record entry in the project directory that the document was rejected and the reason why it was rejected. This record must be linked to the file entry registered for this document in the directory. The record must have a date and time stamp and indicate who created the record
- Only the native copy of all official documents and signed PDF copy of all official project documents shall be stored in the project directory.
- An official project document shall only be allowed to be updated if the following criteria are met:
  - for contractual documentation (e.g. technical specifications, drawings, design criteria, standards etc.) an approved change request shall be supplied (apply the change management control procedure), and;
  - for project processes, procedures (including work instructions) policies, management plans, and any other project documents required for internal use only authorisation is required from the officer/owner
- Any official project document shall only be allowed to be disposed of if:
  - both the project manager and document owner authorises its disposal, and;
  - the instruction for the disposal of the document is confirmed in writing (signed and dated) by both the project manager and document owner.

1.7.3.3. Responsibilities

Document Author

- The author of any project document shall be responsible for the following:
  - identification of the project document,
  - a document number,
  - developing the project document,
  - the storing and distribution of a newly developed or updated document,
  - updating the project document based on feedback received from the document reviewers,
  - obtaining approval of the newly developed or updated project document,

  - ensuring that an approved and valid delegation of authority is attached with the document when necessary, and;
  - indicate the approval signatories required for the document
- The document author and reviewers are jointly responsible for the quality and accuracy of the information presented in the project document.

Document Owner

The owner of any project document shall be accountable for:

- The accuracy and relevancy of information presented in the project document. This automatically implies that the owner is responsible for ensuring that the information in the document is updated as and when necessary.
- Ensuring that the project document is stored in the relevant document repositories. The document author is responsible for the storage of the project document in the project directory.
- Ensuring that project documents are disposed of in line with Mangaung Metro Municipality document retention policies.

Project Administrator

Project administrator/s shall be responsible for the following:

- Registering new project documents.
- Assigning and issuing project document numbers to document authors.
- Storing newly developed, or updated project documents in the project portal and ensuring that the correct statuses are assigned to these documents.
- Performing quality checks on all project documents that must be distributed.
- Distributing project documents when requested. Extracting an “implications list” of configuration items (CI’s) and project documents potentially affected by any official change request and the change management process.

Document Reviewer

Project Team members acting as document reviewers will be responsible for reviewing and commenting on project documents distributed to them for this purpose. This includes making appropriate improvement suggestions on both the structure and content of the document.
Feedback on project documents shall be provided within the time frame indicated on the distribution notice.

Document Signatory

The approval authority of a project document shall be responsible for familiarising themselves with the content of the project document and singing-off on the document if

they approve of the content of the document. Approval of a project document is subject to that document meeting all meta-data requirements for project documents as defined in this procedure.
In the event that one or more of the signatories on a project document does not approve of the content of the document, these signatories will act as document reviewers responsible for providing their comments on the document.

Requirements

- All project documents shall be compiled in English.
- All documents shall be based on the standard templates (styles and formatting) as provided.
- Where no standard template exists for a particular application, an alternative shall be generated and approval sought from the project manager and project officer/owner and relevant approval authority, before use.
- The project's standard office software shall be Microsoft ® Office Professional edition 2010.
- Published documents shall be converted into read only *.PDF format.
- All project documents shall display the standard logos provided.
- Drawing content requirements and drawing border format refer to the engineering drawing procedure.

Document Management Flow Diagram

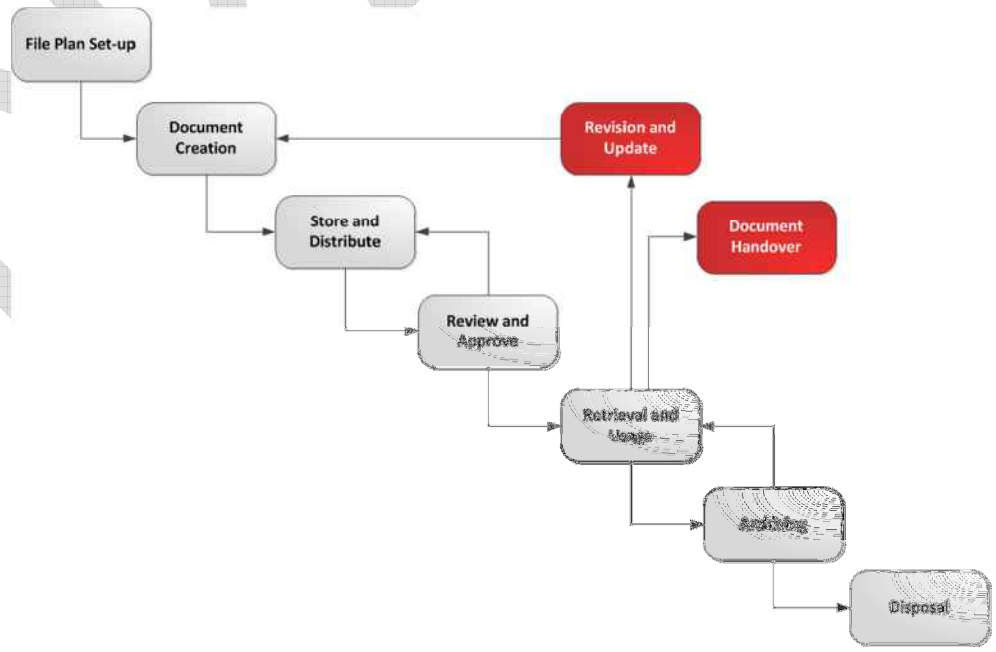


Figure __: Document Management Process

Step 1: File Plan Set-up

Fill in

Step 2: Document Creation

Document Type

Prior to any project document being developed, it is necessary to determine what type of document it will be. This is required to ensure that the correct document template is used when developing the project document. The template for each document type is designed such that it will guide the author as to what information must be included in that document to ensure accuracy and completeness of information, which in turn will expedite approval of the document.

Document Numbering

All project documents and their associated data files shall be numbered and the filenames compiled. The numbering standard should be linked to the WBS elements and project documents, including drawings & contracts.
Project external documentation shall be marked with the relevant unique project number in accordance with numbering standard for the WBS elements and project documents, including drawings & contracts.
The author of a document shall assure traceability of any change to an existing document during all stages of its life-cycle through revision control i.e. the numbering standard for the WBS elements and project documents - including drawings & contracts.
To obtain a document number, the author will have to request the project administrator to issue a document number. The author will have to provide the following information to enable the assignment and issue a new document number:

- the project area (i.e. WBS code) for which the document will be developed,
- the document type, and;
- the discipline

Project Title

The project title is “Mangaung Metro Municipality Bulk Water Supply and Sanitation Project” (MMM-BWSSP).

Project Number

The project number for the MMM-BWSSP is _____

Document Registration

Prior to any new document number being issued the document shall be registered in the project directory (file plan)

Document Register

The project directory shall continually be updated with all meta-data of all project documents, at least those data fields listed in table __ below.
The project portal shall also retain an audit trail of project team members who updated the meta-data.

Table __: Meta Data for Project Document

Data Field	Meaning
(DOC) Number	See number
(DOC) Revision	See revision
(DOC) Title	See title
(File) Location	See location
Approval Authority	The decision makers that decide over the acceptability of the document and related changes. These data may be kept in the distribution form associated with the DOC.
Approval Status	The detail status of the document development phase, as listed in the distribution form.
Attribute: Contract No.	As defined in the document numbering procedure, e.g."C0004"
Author	The author of the DOC. This may be covered by the "responsibilities" data field of a project directory
Baseline	Specific project baseline, i.e. the start of the product life cycle as specified in the document numbering procedure, e.g. a requirements baseline is required before the "**engineering**" life cycle.
Change Controlled	A single digit marker field to identify if the DOC is (change) controlled or not. Default = controlled.
Change History	The trail of change history.
Change Request	The numbers of the change investigation request (CIR) and the change request (CRQ) records as defined in the change management procedure.
Concessions	See deviations /concessions
Copies	The number and allocation of copies to holders of the DOC.
Date Effective	The date when the DOC became appropriate ("effective").
Date Obsolete	The date when the DOC became obsolete.
Deviations /Concessions	A reference number to deviations (DEV)/Waivers and concessions (CON) relating to the DOC, especially to a specification (SPC) and a contract (CTR).
Distribution List	The list of all holders of the DOC. See holders.
Document Links	The file names referenced to/by the DOC.

Document Type	As defined in the document numbering procedure, also called "(DOC) class" in some project directories.
External Number	Unique external reference identifier for the (external) document.
DATA FIELD	Meaning
Holders	The names of roles, people or organisations who received a copy of the DOC. See distribution list.
Items	The (virtual or real CI) items associated with the DOC.
Life Cycle Phase	See baseline.
Location	The document or data repository; for electronic copies it will be the project directory and for hard copies it will physical locations.
Notes	General notes on the DOC. Also see remarks.
Number	Unique CTEP document identifier, as defined in the document numbering procedure. This field normally excludes the actual revision no. that is managed in a separate data field in a project directory.
Reference, External	See external number.
Remarks	Detail notes about the DOC. Also see notes.
Reviewer(s)	The contributors to review the DOC. These data may be kept in the distribution form associated with the DOC.
Revision	As defined in the document numbering procedure, e.g."Rev C" or "Rev00".
Security	The security classification group of the DOC, associated with the holders, i.e. the project directory shall enable constrained access to the DOC by means of this attribute in conjunction with the "holders" attribute.
Superseding	The link to DOCs superseded by or supersedes this DOC.
Title	A pragmatic brief descriptive title for easy identification of the document.

Develop the Document

The author will develop the document using the applicable document template and meet all relevant editorial, technical and contractual considerations. This includes the application of the appropriate document characteristics specified .The author must ensure that they fully understands the specific document requirements and constraints before initiating development of the contents.

Step 3: Store and Distribute the Document

The following shall be done:

- Perform a quality check on the document to determine if the correct meta-data, document template and document number has been entered.
- Store the document in the project directory. Exception: If incorrect meta-data or the wrong document template or document number has been used, the document will be

rejected the document distribution request and inform the author accordingly.
Distribute the document to all resources included in the document distribution form, in the format indicated in the distribution form.

- External distribution - The electronic files are mailed or a CD issued should the file be too big to be emailed.

Issue Options

The following options shall be used on hard and electronic copies to indicate the issue status of documents:

- For approval
- For as built
- For comment
- For construction
- For information only
- For peer review
- For tender purposes

Constraints in use

If a DOC is issued for limited use, the following constraints may be added:

- For design
- For quotation
- For proposal

Engineering Documents

All hard copies shall be stamped for distribution. All controlled hard copies shall have a stamp on the first page of a document.
The stamp will include a “date” and “signature” field that must be completed by the issuer.

Supplier and Vendor Documents

Documents must be stored by the addressee or responsible person (e.g. paper or electronic media) in the project directory along with a document number.
Where vendors issue an electronic copy (PDF format) of an issued document the addressee or responsible person will store the document in the project directory.

Storing

Documents are to be electronically filed in native format and PDF in a document repository. Only one electronic filing repository will be used on this project. The

primary electronic filing repository shall be ___. When a project document has been approved, the author will:

- store a copy of the approved document in both native and PDF format (signed copy), and;
- store a copy of the document, in the appropriate file location, in native and PDF format

The sign-off page of an approved document shall be scanned and stored electronically with the *.PDF-version of such document.
Electronic copies of models and drawings shall be stored electronically in a dedicated CAD environment on the Bigen Africa Services network directory (ProjectWise). Drawings containing comments provided during squad checks will be scanned and filed for archiving purposes.

Issued drawings shall additionally be stored as PDF files in the project directory. Subsequent updates to these documents shall be handled similarly. Bigen Africa Services information management (IM) support shall give the identified Manguang Metro Municipality project members read/write access to the project network directory.

External Documents

All externally developed project documents used on the project shall be marked and linked to the documents associated with the topic e.g. a tender from a tender linked to the relevant contract.

Archives

Only the latest version of a document and its related data files shall be retained in the project directory, to assure data integrity. Older versions will be saved in a suitable document archive repository.

Back-ups

The project server and the project directory repository are backed up in accordance to the Bigen Africa Services IT policy document to an off-site backup facility to limit exposure to loss of information to a maximum of 24 hours.
Regular checks to assure documents are retrievable shall also be done by normal ad hoc restoring of randomly selected data.
A staged data backup shall be done in line with current Bigen Africa Services requirements to retain a history of the development of the project over its total life.

Hard Copy Filing

- **Documents**

All master and secondary master documents shall be saved in folders or filed in paper and electronic format in the Bigen Africa Services filing format with the document number's WBS codification, document type, discipline and sequential number.
Preferably all documents shall be stored in electronic medium only, for all the benefits of a paperless office, e.g. quick retrieval and data integrity. However, as far as stipulated by Bigen Africa Services regulations all paper copies of approved documents with wet signatures shall be retained:

- in the same structure (WBS code, document type, discipline and sequential number), and;
- for the period stipulated by Bigen Africa and contractual guidelines (at the time when this procedure was developed the retaining period was five calendar years from the date when the project phase, for which the document was developed, was completed).

- **Drawings**

Drawings shall be filed in accordance with their WBS number, discipline number and a sequential number allocated on the drawing.
All hard copies of approved drawings with wet signatures shall be retained for the period stipulated by Bigen Africa Services and the drawing procedure.

Step 4: Review and Approve

Reviewers

Every reviewer, including the internal approval authority, shall:

- consider and try to improve on the degree to which a document meets the editorial, technical and contractual needs and constraints for every document on merit in the context of the project requirements, and;
- record their feedback directly into the document using track changes or comments, and submit it to the project administrator, via e-mail. Exception: if the document is a drawing, it shall be acceptable if the comment(s) is entered directly onto the hard copy drawing

The Document Author

The author shall

- Distribute documents for review

- Circulate documents electronically for review by the project team. The request for review will include a cover sheet indicating who the reviewers are and the required completion date for comments.
- When appropriate for the specific document (typically drawings), keep a paper copy of the document in the identified peer review file for the reviewers to visit and mark-up.
- Return such marked up copies at close of review date-time.

Update Document

The author of the document reviews the feedback received from the project team reviewers and, where necessary, the author will engage with the reviewers to discuss their comments prior to the document being updated to ensure adequate understanding of the intent of the comments.
The author then retrieves the stored document (in its native format) from the project directory and updates the document based on the feedback received.
Prior to the updated document being redistributed for final review or approval or external review, the author will update the revision number of the document and document numbering standard as defined in numbering standard for WBS elements and project documents - including drawings and contracts.

External Review (As Required)

External reviews shall apply the review procedure and for the document management flow diagram.

Approve Document

The approval authority (document signatories) signs and dates the document in the space provided on the document, thereby indicating that they approve the document for official use.

Step 5: Retrieval and Usage

To retrieve an official project document for purposes of updating/changing the content or meta-data, the document owner will retrieve the document from the project directory in its native format.

Document Audit

The assurance manager shall assure appropriate audits of the Mangaung Metro Municipality quality plan this procedure and the specific document needs and constraints. They shall consolidate the findings and recommendations in the normal format of audit reports, as prescribed by the quality management plan.

Step 6: Archiving

On project close-out all project information shall be properly archived to facilitate future retrieval for the period stipulated by Mangaung Metro Municipality at the time of archiving.

Step 7: Disposal

Bigen Africa Services IM shall be responsible to dispose a project document and the method of disposal stated in the request provided by the project manager and document owner. If no method of disposal is defined, the document must be shredded in a paper shredder.
The method of disposal defined in the request for document disposal must the project policy, non-disclosure agreements and the inherent company confidential nature of the data and documents, whether the data is marked or not. This includes any draft data and paper copies for proof-reading.
The project administrator shall confirm appropriate disposal of all distributed data & paper copies of documents when e.g. a person leaves employment or when the person leaves the project.

1.7.3.4. Outputs and Deliverables

The document management process covers the total life cycle of all documents and related data.

The following decision processes are important to effective document management:

- Identification and registration of documents to enable reliable project planning and contracting.
- Review and approval of documents should be on time and produce appropriate quality to avoid delays, rework or other forms of waste.
- Change controls their associated documents.

The poor execution of this procedure would logically or materially result in some form of poor performance and risks on all Manguang Metro Municipality processes, notably the following:

- project planning and control
- project contracting,
- project change management,
- project communication,
- project information management,
- project quality management, and;
- risk management procedure

1.7.3.5. Email Communication of Documents

Use

All stakeholders shall use email as primary means of written communication and distribution of document management information to expedite document management. On completion of the communication by e-mail, any agreement on design data or contractual nature shall be captured in the relevant document format and distributed formally.

Identification

The originator shall include into the email subject area the project number, sender/recipient, descriptive (subject) and date. This is required to facilitate efficient management of incoming documents.

Repository

All electronic correspondence of contractual or technical baselines shall be copied to the following e-mail address for proper storage by Bigen Africa Services:
E-mail address to be confirmed

Filing electronic communications

All e-mail on the project will be saved into the relevant data structure (senders; email subject):

1.7.4. Control Budget Estimate (CBE)

The CBE for the project is: ZAR_____ inclusive of a ___% contingency and escalation.

- A detailed breakdown of the CBE is to be included.
- Basis of Estimate

1.7.5. Cost Control

A project cost control management plan has been detailed for Implementation and incorporates the following:

- Estimating
- Change control
- Trend management
- Schedule control
- Commitment control
- Project expenditure control
- Estimate to complete forecast
- Project progress and performance measurement

- Project controls organisation and responsibilities – especially as there could be a number of site offices reporting to different managers.

1.7.5.1. Reporting

The cost report will be summarised to report to the client on original budget, approved changes, current budget and forecast final costs.
The project will utilise an approved cost control system on the project. The project cost system will be set-up at the project planning stage and keep track of original budget, current budget, current forecast, commitments, and expenditures. Budget and forecast will be input to the cost system by the project controls team from estimates and deviations.

On a monthly basis the project quantity surveyor will analyse the data (including commitments and expenditures) in a single report and inform project management and the client of the cumulative impact of any deviations to the project scope. The project quantity surveyor will provide cash flow projections on a monthly basis. The cash flow projections will include projections of both committed and expended costs for the project.

1.7.5.2. Cost Management

Cost Management shall be executed in terms of Bigen Africa's defined process and procedures, with specific reference to the Cost Management Procedure, interface of Financial Systems Policy and Forecasting and Performance Review Guidelines. An Enquiry contractor will price the separate disciplines as stated below:

- Civil and earthworks
- Structural steelwork
- Building works
- Equipment
- Pipelines

These rates are to be submitted by the contractor and will be compared to current market rates with the subsequent placing of the contracts for project execution. The following base date is noted:

- *Base Date:* The base year for this project is _____.
- *Base Currency:* The estimate has been presented in the ZAR currency. Prices obtained in foreign currencies have been converted to ZAR using the approved rates of exchange. All values reflected in the estimate are exclusive of respective country Customs, excise duties and shipping costs.
- *Accuracy:* The accuracy of the estimate falls between the required +15% and -10% accuracy ranges of a Class 4 estimate

- *Cost Breakdown Structure (CBS):* The estimate is structured according to the cost breakdown structure. The estimate is therefore presented with a value per area of the CBS.
- *Estimating System and Format:* The estimate is measured and priced in the Microsoft Excel Windows format.
- *Estimate Report Requirements:* The cost estimate for the project is to be based on a combination of quotations, historical costs and estimated effort of delivery. The cost estimate for the implementation phase will be based on engineering estimates, priced bills and other costs sources from various specialist works stream leads. Provisional sum allowances have been made based on estimated information provided by the client.
- *Estimating Methodology (Overall Philosophy):* The general estimating philosophy was to derive quantities from the engineering and process drawings prepared.
- *The P&G's*: are to be priced/estimated and assessed by the quantity surveyor at enquiry stage. The schedule durations are to be used to determine the time related P&G's
- *The implementation phase contract documents?*

- *Has Provision been made in this estimate for contractual claims?*

- *Basis of Pricing Structure:* The estimate was priced based on current market related rates. The rates will then checked against current market related rates and similar projects. Market conditions will be factored in to achieve a high level of confidence in the pricing structure and mitigate the risks involved.
- *Technical Basis:* The following technical documentation formed the basis of the estimate for the feasibility phase:
  - Civil layout drawings
  - Equipment lists
  - Structural drawings
  - Piping isometric drawings
  - Electrical & instrumentation cable schedules
  - Single line diagrams
  - Vendor specifications & drawings
  - In terms of the measurement of quantities, a general principle applies in which the quantities extracted are wholly based on the available information received from The project engineers.
- *Owners Costs:* The owners cost is calculated based on the project organisation chart.

- *Cost Breakdown Structure (CBS):*

  The CBS is to be finalised and detailed during execution of the implementation phase with the finalisation of the Project WBS.

Description	CBS	Value
Total Project Capital		

Table __: CBS

- *Escalation:* Values have been validated to reflect a base date of _____ applying the _____ escalation indices. Further forecasted escalation for the implementation phase has been calculated for the remainder of the project duration as per the preliminary schedule from _____.

- *Contingency Calculation:* Contingency will be calculated on the risk mode, in conjunction with the client and project team. The risk model will identify schedule, estimate and discrete risks; based on a mean percentile a contingency value of __% is applied.

- *Process Flow for Managing Cost:*

Activity Ref. No.	Process Activity	Activity Description	Rules / Comments
A	Compile the control budget and cost baseline and budget approval	1. The detailed feasibility estimate is the basis of the control budget. 2. Each package of the items within the estimate is coded with a work breakdown structure. 3. The control level will be at the package level, and the escalation per package is determined from the forecasted cost flow per package. 4. As a minimum each package in the control budget will have a supply and/or erect component plus an escalation component. 5. Quantity surveyor will assist in the development of the packaging and the level of control.	
B	Capture budget and release funds	1. The control budget will then be uploaded at the agreed control level; the control level should not be too detailed. 2. The procurement operating plan should be updated to reflect the updated budget and in line with the packaging. 3. All work/ cost breakdown structure directories need to be loaded and updated to enable transactions	

		and provisions for milestones and upfront payments should be made.	
C	Budget shift	1. Upon the request to shift budget the QS identifies the relevant line items in the package and prepares a change notice. 2. The change notice is approved by the project manager thereafter the change is effected in the cost management system. 3. Any changes to the budget will be done via a change notice procedure. 4. Savings identified at a package level must be moved into the project specific saving provision package via a change notice procedure.	
D	Re-allocation of funds	1. Savings from removal of scope items shall be moved into the project specific saving provision package via the change notice procedure. 2. Additional scope items can be funded out of saving provision line items and top-up with contingency via the change notice procedure.	
E	Contracting & adjudication (committing of funds)	1. The discipline lead responsible will write a memo motivating the appointment of a supplier, detailing the appointment method used in appointing the supplier and the scope. 2. The quantity surveyor will be responsible for the commercial and financial input in the process. 3. At enquiry stage, the QS will sign off on all contract recommendations, indicating the budget available for the package to procurement. 4. The recommendation report must have an indication of the Forecast Final Cost (FFC) for the contract. 5. The contract is then sent to the contractor with a coded number.	If no budget is available the cost change control system will be used to allocate funds to the package.
F	Invoice preparation processing	1. 25th of every month – cut off for monthly work included in payment application. The contractor shall prepare and submit payment application in consultation with the quantity 2. 26th – 28th of every month – quantity surveyor shall inspect the site and agree the monthly payment application with contractor. 3. 28th – 30th of every month – payment certificate shall be prepared by quantity surveyor and submitted to the project manager for approval. 4. 01st – 03rd of every month – approved and signed certificate prepared by quantity surveyor shall be sent to contractor to prepare tax invoice according to certified quantities, rates & amounts.	Approval of invoice must be done by commercial and technical representatives.
G	Invoice approval & forecast final cost (FFC)	1. 03rd – 05th of every month – original tax invoice delivered to the Client's offices for attention of the project owner with an updated cash flow forecast. 2. 05th – 10th of every month –project owner and project director shall approve and process tax invoice for payment. 3. The cost flow will be uploaded in order to produce	

		the forecasted cost flow for the project. 4. The Invoice will be circulated for approval. 5. The approved invoice is then forwarded to finance for the payment of the invoice. 6. Once the invoice has been goods received will reflect as expenditure. 7. The contractors will be paid as per the terms of agreement.	
H	Alignment	1. The last working day + 1 the forecast must be updated and overall alignment to original funds release is not crucial, but if it exceeds the budget, and must be highlighted and addressed.	
I	Reporting	1. The various project reports shall be prepared for the relevant stakeholders on an ad hoc basis and on monthly basis as agreed by the management team. 2. Cost is reported on a standard reporting format and project dashboard as agreed for the project.	

Table __: Cost Management Plan

1.7.5.3. Reporting

The following reports will be compiled by the quantity surveyor:

- Monthly cost reports will be generated depicting commitment, expenses, trends and changes. Report will be by cost breakdown structure (CBS).
- Management cost summary report will be a high level report, generated at the end of each reporting month, indicating the following costs in tabular form:
  - Work breakdown structure code
  - Baseline budget
  - Approved changes
  - Current budget
  - Commitments to date
  - Estimate final cost
- The Cost report will be generated by quantity surveyor on a monthly basis. This will indicate, contract value, any scope changes, value invoiced against budget, verifying work performed, and highlighting any possible cost over or under runs.
- Site instructions (SI's) will be issued by the project manager, a copy of the site instruction will be given to project officer/owner and quantity surveyor. The quantity surveyor will calculate and validate the site instruction cost implication and then report the implication to the project officer/owner and project sponsor.
- Progress measurement, trending, forecasting, reporting against baselines
  Progress measurement will be done by making use of two methods:
  - Schedule - The schedule trending will be done as per the description above under schedule management
  - Payment certificates - All progress certificates will be verified by the quantity surveyor, and once approved the invoicing will be completed and issued to the cost and payment process. Forecasting will be done on a monthly basis as per

the cost management plan, and reported on the projects monthly cost template to management.

1.8. FINANCE AND ACCOUNTING

1.8.1. Supplier/Contractor Invoices (as below)

Mangaung Metro Municipality will be responsible for processing of project approved invoices and payment of said invoices.
Progress payment certificates, invoices, etc., will be addressed by the vendor to the project (as detailed in the invoice and payment workflow)
A project specific invoicing, certification, invoice certification and payment procedure shall be developed.
This procedure will address all the aspects relating to the project procedures. It shall address in detail the process of invoicing approval and the levels of authority.
All invoices to items ordered for the project or any other invoice related to expenses to the project will follow the same process.

Invoicing can be generated due to two main activities:

- Services rendered or re-measurable contracts:
  - the invoices need to be issued to the quantity surveyor before the 20th of the month,
  - the quantity surveyor will verify the bill of quantity and issue a payment certificate,
  - this certificate needs to be sent to the cost controller before the 25th of the month to ensure the invoice is in line with forecast figures and contract values, and approved accordingly,
  - the invoice will be sent to the project owner for final payment approval by no later than the 3rd of the following month, and;
  - the invoice will then be sent to Mangaung Metro Municipality for payment before the end of the following month.

- Goods supplied:

  - Invoices will be verified by means of an approval stamp and signature by the project engineering manager to confirm that the material and equipment has been delivered to site and that quantities have been checked.
  - The invoice will be sent to the quantity surveyor to ensure the invoice is in line with forecast figures and contract values, and approved accordingly.
  - The invoice will then be sent to the project office/owner to be approved for payment.

- Invoices will be sent to the finance department for processing within the contract payment period.

All invoices to be addressed to _____ or agreed procuring entity.

1.8.2. Change Management

1.8.2.1. Change Control Process

The project is bound to a long-term timeline that will span several financial years and will therefore focus its efforts on the strict management of any proposed changes to be able to minimise the changes. As part of this management plan the project will make use of a formal change management plan to submit and approve or reject all changes that may be introduced during any of the project phases.

The change management process will track current budget and the forecast, taking into account any deviations (trends), budget shifts, and change orders which have been identified.

The project team will use the following strategy to ensure that design, procurement, and construction efforts are appropriately connected to the project cost estimate and any deviations identified will be reported to project controls:

- Project deliverables and work hour estimates will be compared with the initial estimate to identify any significant changes in scope, duty, size, etc. (and hence in the anticipated cost).
- Supplier prices will be compared with the prices used in the project estimate to identify any significant differences.
- Quantities of bulk materials will be compared with the amounts included in the project estimate.

The quantity surveyor will also perform comparisons to the control base that will include, but not be limited to, take-off quantities, unit prices, work hours, changes to equipment or specifications, and changes in project execution. Any deviations identified as a result of these comparisons will be processed through the deviation system.

In general no scope or design changes are to be actioned until approved in writing at the appropriate level.

Once a change or potential change has been identified, a decision will be taken by the project manager as to whether work in the area concerned is to be stopped, or continued on the previously agreed scope – until such time as the change is approved.

In the case of a proposed plan the following procedure will be followed:

- Submit a change request to the project manager by completing the change request form.
- The applicant needs to complete the questionnaire with as much detail as possible including the expected project impact and cost.
- Submit the completed document to the project manager for review and impact assessment.

- The project manager will submit the document to the steering committee for review and further action.
- The project manager will inform the applicant of the approval process.

The change control form will be used, as well as the financial approval process and limits as set out in the project's delegation of authority framework agreement.

1.9. RISK MANAGEMENT

1.9.1. Risk Management Plan

The risk management plan identifies areas of potential risk, integrates potential risk events, and provides courses of action and methods of control and establishes a comprehensive risk response methodology.

1.9.2. Technical Risk Assessments

1.9.2.1. Baseline Risk Assessment

The appointed contractors shall conduct a baseline assessment to determine its current risk status. Through this process major risks will be identified and prioritised for future control.

All risk assessments will be in writing and approved by the construction managers and will typically consist of the following:

- Identification of hazards (energy sources)
- Identification of major health and safety risks;
- List of controls to be implemented (when and who);
- Formal action list for implementation
- Continual improvement by proactive identification of shortcomings identified.

1.9.2.2. Issue Based Risk Assessment

Issue based assessments must be conducted prior to activities where new hazards or risks may be introduced into the operation or on request

This assessment must be in writing and must be approved by the project manager and construction managers and will be required:

- For new work method or systems
- For new machines or equipment
- Following the occurrence of an accident or an incident
- After obtaining knowledge that may influence the level of risk those employees are exposed to.

1.9.2.3. Continuous Risk Assessment

The continuous risk assessment should be done as part of the daily programme of the contractors or as may be required by the safety management system. Continuous assessments are the responsibility of line management especially first line supervision. Continuous assessments may include but are not limited to:

- Audits
- Management walk-about
- Meetings
- Pre-operational inspections
- Daily safe task instructions (DSTI's)
- Suggestions and safety awareness programmes
- Toolbox talks
- Mini task risk assessments

During the contract, the contractors, his sub-contractors may identify additional hazardous operations. For each such newly identified hazardous operation, the contractor shall prepare and submit to the project manager, a risk assessment as described above. The contractor shall not proceed with the work/operation in hazardous locations until the project manager or authorised delegate has reviewed the risk assessment and has approved the risk assessment form and a valid permit to work has been issued.

1.9.2.4. Principle Hazards

Site Specific hazards shall be listed in the principle hazard register. From the original risk assessment process identify those hazards where the consequence has a potential for multiple serious injury, illness, multiple fatalities, or other disastrous outcome related to safety, health or the environment. The principle hazard management programme shall be developed by:

- Application of special techniques to ensure detail evaluation of each principle hazard (bowtie or fault tree analysis).
- Evaluation of current controls and implementation of additional controls where necessary.
- Communication and maintenance of a formal programme to manage the principle hazards identified.
- Scheduled assessments to measure effectiveness and performance on the journey to excellence.
- Different stages to be considered during the development of the principle hazard control plan are:

The following is an overview of the risk assessment process that should be followed for the project:

Project Phase	Type of Assessment
Study	High Level Risk Assessment (HLRA)
Conceptual	HAZOP 1 – Review of block plan.
	HAZOP 2 – Review of PFD's.
Pre-feasibility	HAZOP 3 – Review of P&ID's.
	HAZCON – Constructability review. (At discretion of lead)
Feasibility	HAZOP 4 – Review of constructed building, structure, etc. Normally done with final punch list.
Execution	HAZOP 5 - Review of constructed building, structure, etc. Done before commissioning.
	HAZOP 6 - Review of constructed building, structure, etc. Done after commissioning before handover.

Table __: Risk Assessment Process

Note: Hazop 1, 2 and 3 are progressively reviewed at the start of the project implementation phase.

- Formal prevention plan communicated on all principle hazards with suitable training to be able to understand the consequences.
- Signs of eminent danger related or originated from this source or combination of sources.
- Understanding and identify the "energy out of control" conditions.
- Initial response plan (1st response when event occurred for quick mobilisation).
- Emergency response plan.
- Recovery (stay in business by ensuring the post events effects are minimised by application of the best attempts).
- Regular review, as and when required, of all risk assessments will be done.

1.9.3. Risk Assessment and Register

The project team and other stakeholders will conduct a qualitative risk assessment for the project on regular and defined intervals. The result from this risk assessment will be converted into the risk register and accordingly maintained, with monthly updates or as required. A formal risk assessment is to be performed for implementation at defined monthly intervals and informal assessments as required on an adhoc basis.

1.9.4. Review Schedule

The project review schedule is a summary of all project reviews that will be conducted through-out the life cycle of the project. The review schedule details the type of review, the frequency and the required attendees at the review

A quantitative schedule risk analysis is to be undertaken utilising the schedule for the undertaking of the implementation phase of the project and reflected in the gantt chart of the overall project master schedule.

The schedule will be imported into a suitable risk analysis tool to undertake the schedule risk analysis and a Monte Carlo simulation utilising a minimum of 10000 iterations will be run. The results of the post-response analysis will be reflected as a distribution that in

terms of implementation indicated at a client defined confidence (P90). In addition to the risk distribution a tornado graph will depict the top 10 risks that have the highest correlation between occurrence and the delay in completion of the project.

1.9.5. Review Cost

Quantitative cost risk analysis will be undertaken for implementation by determining the potential delays due to risks that would increase costs and modelling the resultant cost impact using @Risk© or a similar approved software. The cost impact is directly related to delay; again the tornado graph will depict the ten risks that have the highest correlation between their occurrence and cost impact of risk on the project.

1.10. ENGINEERING AND DESIGN

The consultants will be responsible for the overall detailed design and engineering in relation to the following construction work packages of the project that will be undertaken under a principal contractor's scope of works:

- Civils and earthworks
- Pipe-laying
- Structural
- Construction
- Electrical supply and reticulation

The project's implementation strategy as follows will apply:

- The project strategy as mentioned before related to the engineering and design strategy is as follows:
    - The complete design function will be the responsibility of the consultants.
    - All approvals by the client will include general arrangements and detailed design.
    - Comments received from the client related to practical maintenance and safety will be considered.
- If there are additional requirements for infrastructure or the designs related to the infrastructure, the engineering design interfacing will be managed and dealt with as follows:
    - A fortnightly engineering interface meeting will be conducted as described in the meetings list, to be able to discuss construction interfacing issues as well as any new design approvals that is required.
- Any documentation or approval requests will be routed via the document management system to be able to facilitate revision control and approval progress. Any information related queries or issues will be registered in the issue register and traced accordingly to be able to close these issues or requests in a timely manner.
- Work progress will be controlled by making use of the schedule as a tool to measure the planned completion versus actual progress.

- The cost will be controlled by making use of a standard monthly prior forecast and actual comparison as being used for the project.
- Any reviews checks or sign-offs will be managed through the document management system already operational within projects

1.10.1. Engineering

The engineering design packages will be compiled based on the engineering design criteria (EDC) and approved by the Project. Bigen Africa Services will be responsible for the overall detailed design and engineering in relation to the equipment installation packages of the project that will be undertaken under the selected or nominated contractors' scope of works.

1.10.2. Discipline Engineers

Project design criteria are required to be defined. What client specifications will be utilised?
The discipline engineers assigned to the project will be responsible for the detailed engineering and specifications of the project. The discipline engineers will also be responsible that the detail designs are reflected accurately on the drawings produced.

1.10.3. Drawings and Standards

The Mangaung Metro Municipality drawing standards will be utilised on the project. The CAD will be done using AutoCAD.

1.10.4. Project Deliverables

During the detailed engineering phase the project engineers will determine the project deliverables to be completed as part of the project. A complete list of the project deliverables is to be attached.

1.10.5. Engineering Design Reviews

Engineering design reviews will be conducted as per design meetings.

1.11. PROCUREMENT

1.11.1. Procurement System

The primary goal of the procurement activity is to procure equipment, materials and services for the project from the most economic source taking cognisance of quality,

delivery, reliability, specialist capability and services. All activities are to be transparent, duly authorised and subject to audit within the dictates of the project procedures.

Procurement will need to adhere to the following legislation:

- Public Finance Management Act 1 of 1999 (PFMA)
- The Local Government: Municipal Systems Act 32
- Municipal Finance Management Act 53 for 2003 (MFMA)
- Preferential Procurement Policy Framework Act 5 of 2000 (PPPFA)

The following factors are to be considered when defining the packaging strategy for the bulk water and sanitation project:

- Site
- Technology
- Contract supervision
- Completion date
- Long lead times
- Contractor capability

The requirement will be to pre-qualify and shortlist competent contractors to reduce the need to evaluate unqualified tenderers whilst gathering company information accordingly. It is a way of narrowing the field to only those who have the requisite ability to comply with the terms of the contract and the organisation, technical and financial capability to undertake the work. It further confirms the tenderers presence and experience and broadly identifies the extent of experience, knowledge, skill and competence that tenderers possess.

A CIDB grading level of 9 or approved grading level as per Mangaung Metro Municipality is to be stipulated.

The sourcing of long lead items and single source procurement will be determined after detailed consultation between the project manager and the client project officer.

The project will accommodate a public–private partnership (PPP). A PPP will involve a contract between Mangaung Metro Municipality and a private party, in which the private party assumes substantial financial, technical and operational risk in the project. Capital investment is to be made by the private sector on the basis of a contract with government to provide agreed services and the cost of providing the service is borne wholly or in part by government. As with this project that is aimed at creating public goods in the infrastructure sector, the government will need to provide a capital subsidy in the form of a one-time grant, so as to make it more attractive to the private investors. In some other cases, the government may support the project by providing revenue subsidies, including tax breaks or by removing guaranteed annual revenues for a fixed time period.

The two fundamental drivers for a PPP are:

- PPPs are claimed to enable the public sector to harness the expertise and efficiencies that the private sector can bring to the delivery of certain facilities and services traditionally procured and delivered by the public sector.
- PPP's are structured so that the public sector body seeking to make a capital investment does not incur any borrowing. Rather, the PPP borrowing is incurred by the private sector vehicle implementing the project.

A PPP project where the cost of using the service is intended to be borne exclusively by the end user, the PPP is, from the public sector's perspective, an "off-balance sheet" method of financing the delivery of new or refurbished public sector assets.

1.11.2. Procurement Schedule

The procurement activities will need to be included in the project schedule or otherwise known as the procurement operating plan (POP) and detailed as follows:

Task Name	Period / Duration	Activities Included in Task
Prepare and issue Enquiry	XXX	XX.
Tender Period	Xx	Xx
Adjudicate Enquiry	Xx	Xx
Place Order	xx	xx

Table __: Procurement Operating Plan

The sequence and priority of the different procurement packages are determined by the project schedule. It is recorded that some packages of work were awarded in advance of the main construction contract provided as it was demonstrated essential for achieving the final completion date of the project.

1.11.3. Procurement/Contracting Strategy

Procurement will be based on the principles of a single type of principal contract which has been deemed appropriate for the work package scope and nature of the works. It is noted that the FIDIC (Red Book) form of contract will be utilised for all construction related works to be packaged.

The responsibly of the project officer is as follows:

- Finalise the functional requirements with each operating division (OD).
- Ensure that facilities are designed and constructed to the appropriate quality and operational requirements to satisfy the functionality requirements.
- Ensure that the project is completed in a timely, efficient and safe manner, and within the approved budget.

- Ensure that project procurement, contracting and management complies with the Mangaung Metro Municipality policies and applicable standards.

The client project officer will appoint through a closed nominated consultancy agreement using the _____ professional service agreement:

- A project manager for the bulk water supply and sanitation project.
- Contractors will be appointed through a prequalified and short-listed tender process using FIDIC (Red Book) form of contract.
- Appointment of specialist contractors through a pre-qualified selected sub-contract tender process using the FIDIC (Red Book) form of contract.

The project manager will:

- Clearly define the battery limits for the service provider.
- Appoint a dedicated and experienced engineering and project team adequately resourced to ensure that governance is adhered to and that the project is properly executed.
- Ensure that the delivery schedules of the various contractors are properly integrated and further ensure that the schedule delivery dates for the project are met.

The project manager will further interface with:

- The various stakeholders for the procurement, supply and logistics of materials and equipment to the project and the appointed contractors.
- Project steercom for overall project governance and progress.
- Mangaung Metro Municipality in respect to operational readiness.
- Mangaung Metro Municipality for the management of the power supply / upgrades by ESKOM.
- Statutory and regulatory bodies in terms of Town Planning and Building Plan Approvals
- Mangaung Metro Municipality for the acquisition of land and registration of servitudes.

1.11.3.1. Equipment and Activities

All the equipment/activities associated with the package/contract are specified.

1.11.3.2. Approved Vendors

The vendors and contractors to be invited to tender for the required services or equipment packages shall be according to the latest revision of the project procurement contracting strategy. Enquiries will only be issued to approved and short-listed vendors.

For any additions to the vendor and contractors list, the list must be updated and approved. The tender process will take place in two phases:

- Phase 1 – pre-qualification: Includes company information
- Phase 2 – Tender submission: Includes company performance and track record on similar projects and the financial offer for the services to be provided.

A competitive selection procedure will be adopted in both phases. The first phase will comprise a two envelope system. Tenderers will be asked to submit technical and financial proposals in two envelopes. Envelope 1 is the "functional offer" and envelope 2 the "financial offer". The opening of the financial offer is subject to an acceptable functional offer being submitted.

The following selection criteria are intended to assess the competence of the tendering organisations to achieve the required project outcome and are used to rate each of the tenders:

- Past performance
- Management and technical skills
- Resources & organogram
- Methodology
- Price
- CIDB rating
- BEE certification

Following successful evaluation of Phase 1 (Pre-qualification), a minimum of 3 and a maximum of 5 highest scoring respondents will be eligible for invitation to collect and submit tender documentation for Phase 2.

1.11.3.3. Contract Documentation

All procurement for the project will be done using the client standard terms and conditions and if not available, the quantity surveyor will compile standard terms and conditions suitable for the project. Where one entity indicates detailed process and procedure, that company's documentation will take precedence over the other. The following will apply:

Procurement	Standard Terms and Conditions
Equipment	Mangaung Metro Municipality modified conditions
Proprietary Equipment	Mangaung Metro Municipality modified conditions
Professional Services	Mangaung Metro Municipality modified conditions
Low Value Items	Mangaung Metro Municipality modified conditions
ALL CONTRACTS	**FIDIC suite of documents**

Table __: T&C register

1.11.3.4. Strategy

The strategy for each package will be determined as follows:

Strategy	Basis of Strategy
Selected Tender	Proprietary Equipment Proven Supplier Low value item
Conforming Enquiry	Formal Revalidation of Commercial and Technical detail.
Negotiation (Conforming)	Negotiation required to finalise on contract conditions.
Closed Tender	Obtain favourable available terms.

Table __: Tender Strategy schedule

The project procurement contracting strategy is active and should be revised as and when requirements on the project changes.

1.11.4. Validity of Tenders

All quotes to be valid up to and including **ninety days (90)**.

1.11.5. Performance Guarantees

Contractors will be required to arrange for a performance guarantee to be issued to the client. The project manager shall, as soon as the contract has been signed, request a guarantee to be issued to the client. As soon as the contract is completed the client shall be asked to return the performance guarantee.

1.12. MATERIALS MANAGEMENT

Material handling is the field concerned with solving the issues associated with the delivery, movement, storage, control and protection of materials and equipment throughout the processes of ordering, preparation, manufacture, distribution, consumption and disposal of all related materials, goods and potential packaging. The material handling in specific to this project will need to address the refurbishment and distribution of materials, equipment and services required during the construction execution, from obtaining, locally procuring and transporting raw materials to utilisation of off-the -shelf stocks in supplier processes.

Material handling in specific to this project will require secured, defined and controlled lay-down areas for components, materials and equipment geographically for the project. Handling and storing materials will involve diverse operations such as hoisting steel with a crane, hoisting equipment with a crane, driving a truck loaded with ready mix concrete, placing bags and material, and stacking, moving dunnage lumber.

The efficient handling and storing of materials is vital to this specific project. These operations provide a continuous flow of materials, parts, and assemblies through the construction sites and ensure that materials are available when needed. The improper

handling and storing of materials can cause significant and costly injuries and therefore materials handling is closely associated with Health and Safety.
Since numerous injuries can result from improperly handling and storing materials, it is important to be aware of accidents that may occur from unsafe or improperly handled equipment and improper work practices and to recognise the methods for eliminating, or at least minimising, the occurrence of those accidents.

1.12.1. Expediting

The various professional team disciplines and quality control will be responsible for the expediting of procured material and equipment. Purchase orders placed on suppliers will be subject to expediting, inspection and release by an accredited inspector.

1.12.2. Supplier Quality Control

Suppliers' quality control will be managed by the responsible discipline lead engineer/s and client counterpart.

1.12.3. Warehousing and Stores Control

No warehouse or stores control will be set up for the project. Each of the contractors will be responsible for receiving, storing and releasing equipment from their own designated laydown areas. The discipline engineering site supervisor will ensure that the equipment is inspected.

1.12.4. Materials Supply

Construction materials and consumables - The more important construction materials and consumables are fuel (for construction equipment), water, (for earthworks construction and concrete) cement (concrete construction work) steel reinforcing, (reinforced concrete) safety equipment and PPE, (overalls, safety boots, hard hats, gloves, safety googles) and small tools and construction consumables (power and hand tools, wire, nails, concrete floats, etc.).

1.12.5. Materials Management

The contractors and client project officer/owner will define, within the materials management and logistics plan, their adopted approach to materials management on site, and philosophy with regard to stores control, supplier quality control etc.

1.12.6. Logistics

Logistics of material supply to sites for the construction works will typically involve the delivery of all materials by road. All relevant enabling works packages to support these

logistics (e.g. wayleaves and access road strategies) are to be completed in advance of material supply.

1.13. CONSTRUCTION

Commentary on site establishment / environmental interface / logistics will need to be developed in detail during implementation phase of the project.

Actions to be executed:

- Client field representative,
- Site access,
- Construction offices/stores,
- Construction utilities,
- Electricity, telephone/fax,
- Water,
- Fuel,
- Below ground obstructions,
- Delivery addresses and site establishment.

1.13.1. Construction Organisation and Responsibilities

The contractors will be responsible for the management of their site teams and all the sub-contractors on site. Once access is given to the appointed site contractors the appointed contractor's site manager/agent will be fully responsible for all activities on the specific identified site.

1.13.2. Construction/Site Management

The construction/site management will be supplied by a contractor.
The contractor is to use in-house construction expertise and input during the design phases. The project team has ample experience in similar projects and this background is used to ensure good practices and workable construction concepts.
The construction sequence will be defined by the detailed schedule and construction schedule, and will take into account the site logistics, space limitations and constraints and the contractor's manpower and resources.
The contractor will be required to provide a site safety officer for the duration of the project. Safety involves every person on site and in the site offices therefore, every person arriving on site will attend the necessary induction and comply with all safety requirements. On site, a team comprising construction/site manager/agent, supervisors, and relevant sub-contractors supervisors will be appointed, and although each has clear responsibilities, they will also assist with safety as necessary.

1.13.3. Constructability of Design

During the detail design process, constructability reviews will be undertaken to ensure that the designs are constructible and aligned with the defined construction strategy.

1.13.4. Industrial Relations

The industrial relations policy forms part of an overall concept of sound industrial relations, safety, health and environmental policies, procedures, regulations and practices for the expansion project.

Industrial relations submissions and to co-ordinate and monitor the operation of the principal contractors industrial relations activities on the project and to ensure that the principal contractors manage their industrial relations in a proper manner so as to ensure that industrial relations incidents are minimised and effectively resolved.
The project manager desires that the industrial relations procedures and practices that are implemented on the project are uniform and consistently applied by all contractors and service providers.
The following procedures need to be covered within the IR policy for the bulk water and sanitation project, but are not limited to, for example:

- Disciplinary code and procedures
- Grievance procedures
- Dispute resolution procedures
- Absenteeism procedure
- Demobilisation procedure.

Such practices include but are not limited to, for example:

- Transport requirements and standards to and from site
- Pro-forma contracts of employment (limited duration and secondment contracts)
- Standard wage rates aligned to job categories for the respective industry sectors
- Hours of work and overtime
- Long weekend arrangements
- Conduct of the parties in the event of industrial action
- Tool policy
- Recruitment and employment arrangements
- Communication structures and process flow, etc.

Such procedures and practices are to be included in the principal contractors IR policy and become contractually binding on all sub-contractors.

1.14. COMMISSIONING – TESTING, HANDOVER AND ACCEPTANCE

1.14.1. General

The Project Team will be responsible for the following:

- Handing over the custody and control of the project, its sections/areas and systems to the client in an orderly manner and in a sequence to be agreed and reflected/scheduled in the project schedule.
- Ensuring that acceptance of the project asset is in accordance with the project's scope and procedures are agreed for this purpose.
- Upon completion of an area, section or the whole project asset, the project manager will issue the required work completion certificates. The completion which will encompass civils, structural, construction, mechanical, electrical, equipment and instrumentation and completion of commissioning activities as may be appropriate for acceptance by the client, with the responsibility resting with the client appointed responsible persons.
- Upon accepting the relevant area, section or complete project, care custody and control of those areas, sections or complete project will pass to the client.
- When all areas of the project have been accepted, the project manager will issue an overall project final completion certificate for acceptance by the client, hereby transferring the entire facility to their care, custody and control.

1.14.2. Commissioning

In general terms commissioning occurs in three (3) primary phases:

- Construction works completion (project management responsibility, with contractor input).
- Pre-commissioning (client team responsibility with direct contractors).
- Commissioning (client responsibility, direct contractor team input).

Only thereafter will the entire infrastructure be run and fully tested as a whole unit.

- Shutdowns, tie-ins and interface with the current operations will be done in full co-ordination with the operations personnel in order to minimise or eliminate any possible disruption to current operation.
- The project team, the operations department and the construction team will take ownership of the commissioning process and of putting into operation a project that fully complies with the original design parameters.
- The commissioning procedure will be updated and adjusted to accommodate the any special requirements as this project spans both greenfield and brownfield sites.

- In general terms, each piece of infrastructure and equipment will be commissioned and each component line tested. Only thereafter will the total operation be run and fully tested as a whole.
- The project team, operations staff and the construction team will take ownership of the commissioning process and of putting into operation a project that fully complies with the original design parameters.
- Commissioning and acceptance criteria are to be finalised and issued for inclusion into the PEP.

1.14.2.1. Construction Commissioning

Due to the nature of the works being predominantly building works there are a limited number of commissioning elements and most inspections and tests will be undertaken through the Quality process, with production of resultant signed Quality Control Plans. However, commissioning procedures are required to be developed for all automation and electrical power works for cold and hot commissioning to be undertaken by the Client and nominated contractors. A commissioning plan will address:

- Commissioning to be undertaken in line with Novus Holdings guidelines.
- Health, Safety and Security during commissioning.
- Sequencing of events from a construction site through to an operational paper mill. This includes relates permits, handover processes.
- Define responsibilities for site at the different stages of commissioning during commissioning and handover phase.
- Determination of permits required once elements go 'live' e.g. live power feed will require certain permits whilst working in proximity.
- Certificates required for handover.

1.14.2.2. Client Commissioning

The client will have three levels of commissioning of the works. There will be commissioning of the packages for which it is responsible, bulk water supply pipelines, and water and effluent treatment and pump stations. There will then be integrated commissioning and trial running of the completed works. The client is required, prior to the commissioning phase, to produce appropriate commissioning procedure to govern the commissioning process. Key items with regard to the timing and staging of client's commissioning include:

- Inspection and confirmation is required that there will be no consequent infringement of clearances etc. on the main works design.
- Electrical power supply will be required to be available prior to client commissioning of own packages.
- Commissioning of interfaces with controls.
- Timing of commissioning with regard to completion.

- Any interfaces with commissioning of interfacing existing operational sections of project.
- Strategy for trial running.
- Integration with project for operational readiness.

1.14.2.3. Brownfield Interfacing

The project will need to perform several tie-in activities, with the brown field operations. These tie-in activities will need to include the following:

- The procedure to obtain working permits in the specific areas of work is adopted as per a safety requirement. This section is to be further detailed as Brownfield project detailed scope of work becomes available.

1.15. OPERATIONS AND MAINTENANCE

1.15.1. Training of Operational Staff

No formal operator training will be conducted by the contractors during construction hand over and commissioning, client personnel will assist operations and maintenance personnel with “on the job” training.
In order for the “on the job” training to be successful the operations and maintenance personnel may be seconded to the project.

1.15.2. Operational Readiness and Maintenance Programme

The contactors are to engage with the client’s representatives during the early stages of implementation. The objective is to understand their requirements and to ensure that all relevant design and construction related operational readiness aspects have been accounted for in the project scope. The contractors are to then work with the client to ensure their operational readiness requirements are achieved (e.g. training, closure of hazard actions, production of as-built drawings, functional close out, agreements with utility providers etc.).
The operational readiness function will also encompass and support the development of maintenance plans to define required training, experience, spares, availability of maintenance equipment, production of maintenance plans and procedures etc.

1.15.3. Operability, Safety and Maintenance Reviews

As part of the defined risk management execution process a series of hazard studies will be undertaken, documented and the output mitigating actions implemented. The aim of these hazard studies is to understand how the design can be adapted to avoid hazardous situations during operations or maintenance, how construction can be managed to

minimise the risk to personnel and how commissioning can be managed to ensure safety of personnel. The contractors are to produce a documented hazard close out document which details proof that all hazard mitigations have been implemented and indicate which hazards pose residual risks.
Throughout the detail design process various reviews will be undertaken by the professional team. Interface with the relevant client operation departments should be sought and involved in the reviews where appropriate

1.16. PROJECT CLOSEOUT

Technical reviewers will review the work of consultants progressively throughout the execution of the implementation phase, and will support the project manager. These technical reviewers will be appropriately qualified personnel.
The client will utilise appointed resources to review the implementation. It is expected that a single review will be held over a period of approximately **6 Months.** This will be planned well in advance to ensure that the assigned resources are given adequate notice of when it will be required to review the work undertaken in the implementation phase. The review process for the implementation report shall be as follows:

- Issued for internal review (IFIR): Allocated responsible persons to review their respective sections to ensure that information has been correctly transferred from the individual reports into the final report.
- Issued for client review (IFCR): Project manager to circulate the document to the appropriate department heads for review and comment.
- Issued for Approval (IFA): The client comments will be incorporated and the document re-issued for approval signature. This signifies completion of the document.

Time allocated for reviews and the return of comments shall be as detailed in the master implementation Schedule. The approved copy of the report will be issued by the project manager for toll-gate review. This process will be undertaken by client using its in-house processes and procedures. The purpose of this plan is to provide a framework for the ordered close-out, collecting and recording the lessons learned during the implementation and the preparation of a close-out report to capture the major outcomes against the baselines and the learning's. A project close-out management plan will be developed in order to close out the project in a controlled and consistent manner. The closeout plan will include the following areas:

1.16.1. Administrative Closeout

The project manager will issue a complete set of project drawings and documents to the client on completion of the project. A project close-out report will be prepared by the project manager and issued to the client. The report will report on project success,

effectiveness and lessons learned. There are mainly four areas that need to be closed out at completion of the project:

- Procurement – that forms part of the procurement close out plan
- Documentation – that forms part of the documentation management
- Lessons learned close out – this information sharing session will be done in cooperation with the knowledge management manager (or equivalent) to capture lessons learned and recommendations for future projects.
- Staffing – at the end of the project the contractor's contracts will be closed out and the permanent staff members will be incorporated back into the discipline departments.

1.16.2. Contractual Closeout

Contractual close-out of all orders will be done by the Quantity Surveyor up to contract completion/hand over. Contract documentation includes the contract itself along with all supporting schedules, requested and approved contract changes, any seller developed technical documentation, financial documents such as invoices and payment records and the results of any contract related inspections or audits. A complete set of indexed records will be prepared for inclusion with the final project records.
The administration of the contract through the defects notification period and payment of retention or return of retention bonds /performance guarantees as well as final close-out will be done by in conjunction with the project owner and the project manager and project sponsor. The project manager will issue a list of contracts indicating when payments are due.

Defects liability?

1.17. CONTINUOUS IMPROVEMENT

1.17.1. Knowledge Management

1.17.1.1. Peer Assist

Peer Assist meetings or workshops will be arranged during the project when the project is faced with a specific challenge or problem. People not directly involved in the project will be invited to share their experience, insights and knowledge and potentially recommend further areas of investigation. The aim is to maximise the outcome for a specific piece of work.

1.17.1.2. Post Implementation

Review on completion of the project, a project post implementation review will be held to capture learning from the project. Lessons learned discussion and updating of the

lessons learned register shall not be a once off event, but rather an on-going effort. Also refer to the closeout section in this document.

2. APPENDICES

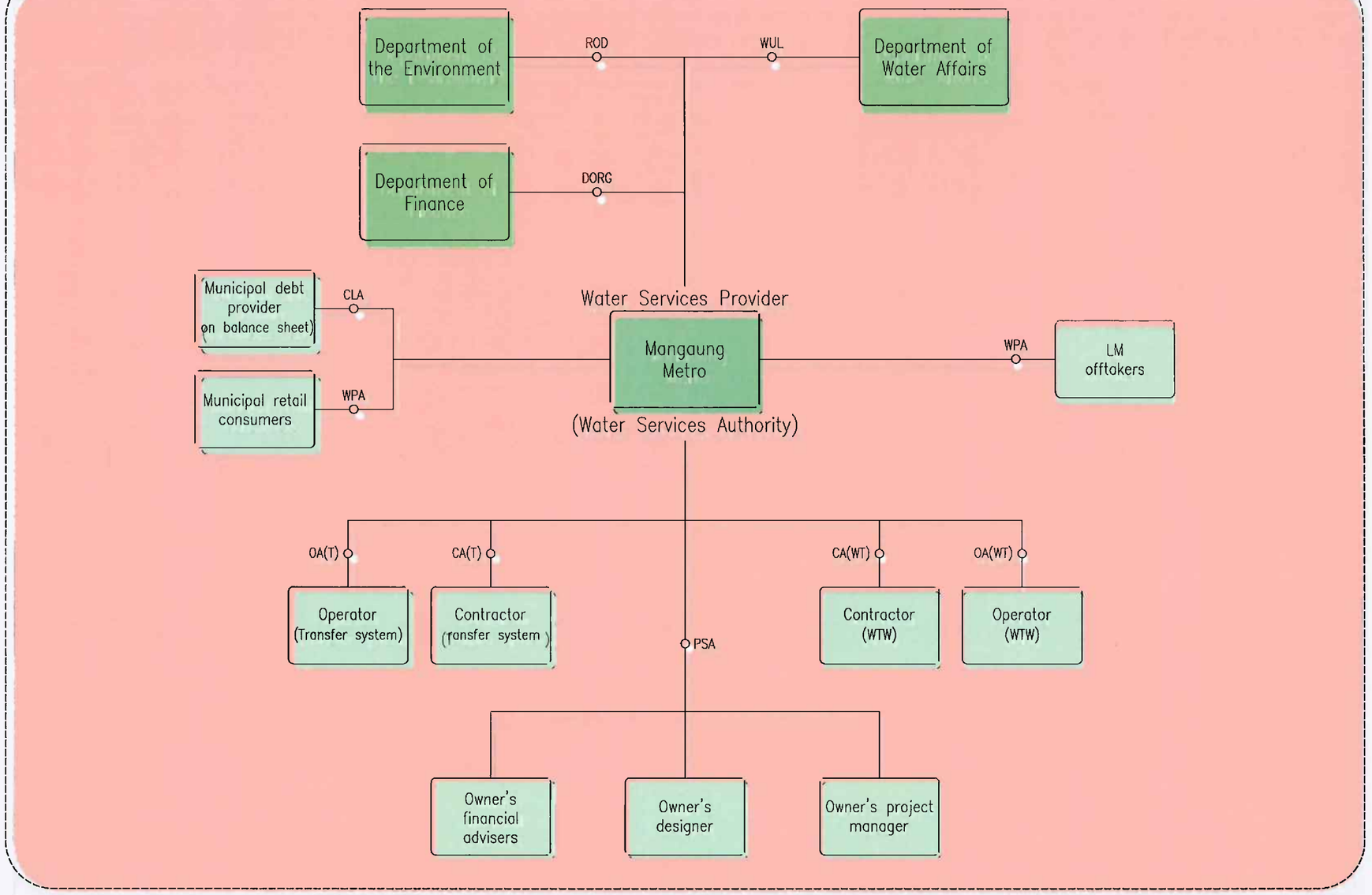
Annexure H – Preliminary budget for development of BFS

	Cost estimate for Garlep Augmentation Project Bankable Feasibility Study		Notes
1	**Technical and Engineering Aspects**	**R 22 826 000**	
1.1	Project management function	R 1 584 000	
1.2	Complete preliminary design all GAP components	R 21 242 000	
2	**Procurement documentation**	**R 17 888 000**	
1.3	Prepare construction procurement documentation	R 17 888 000	
3	**Specialist investigations and land use**	**R 6 000 000**	
1.4	Land use management	R 3 000 000	
1.5	Commission specialist studies for EIA, geotech and topographic surveys	R 3 000 000	
4	**Project Structuring Aspects**	**R 1 000 000**	
2.1	Develop appropriate project preparation and implementation structure	R 1 000 000	
5	**Financial modelling Aspects**	**R 2 500 000**	
3.1	Refine project CAPEX estimates		Included in 1.2
3.2	Refine project OPEX estimates		Included in 1.2
3.3	Evaluate and select most cost effective operational scenario		Included in 1.2
3.4	Establish project financial model (preparation, implementation and O&M stages)	R 1 000 000	
3.5	Establish revenue model and detailed tariff model to establish affordability of GAP	R 1 500 000	
6	**Funding and structuring Aspects**	**R 5 750 000**	
4.1	Identify potential grant funding sources	R 1 000 000	
4.2	Identify potential commercial funding sources	R 250 000	
4.3	Determine funding conditions		Included in 4.1 and 4.2
4.4	Confirm multiple project underwriters	R 500 000	
4.5	Develop a funding model and update project financial model.	R 1 500 000	
4.6	Update revenue, cost recovery and tariff model with funding sources identified	R 1 250 000	
4.7	Confirm affordability	R 250 000	
4.8	Confirm bankability	R 250 000	
4.9	Confirm conditions met for BFS and conditions precedent.	R 750 000	
7	**Legal documentation Aspects**	**R 3 000 000**	
5.1	Develop suite of procurement documents		Included in 1.3
5.2	Develop suite of agreements	R 2 500 000	
5.3	Renegotiation new MMM- Bloem Water supply agreement	R 500 000	
8	**Statutory approval Aspects**	**R 1 800 000**	
	TOTAL	**R 60 764 000**	

Notes

1 The BFS cost estimate is a provisional sum and depends on the implementation model adopted by MMM
2 The design was based on the assumption that a preliminary design will be done before procurement commences
3 The procurement documentation was based on the assumption that procurement will proceed on an EPC basis
4 The fees allowed for funding, structuring, financial modelling, legal documentation and statutory approvals was a provisional sums
5 It was assumed that a project manager will be employed during the project preparation for a period of 12 months

Annexure I – Project Structuring



LEGEND

WUL	Water use license
ROD	Record of decision
WPA	Water purchase agreements
PSA	Professional services agreement
DORG	Division of revenue grant
CA(T)	Construction agreement (transfer)
CA(WT)	Construction agreement (water treatment)
OA(T)	Operating agreement (transfer)
OA(WT)	Operating agreement (water treatment)

AS-BUILT RECORD

CONTRACT No.	DESCRIPTION	CERTIFIED BY	DATE

CERTIFIED AS-BUILT FOR CONTRACT :

ENGINEER DATE

VERSION/AMENDMENTS

No.	DATE	DESCRIPTION	AUTHORISED BY

BIGEN AFRICA Services (PTY) LTD
Allan Cormack Street
The Innovation Hub Persequor Pretoria
PO Box 29 The Innovation Hub Pretoria 0087
Tel:+ 27 (0) 12 842 8700
Fax:+ 27 (0) 12 843 9000/9001
E-mail: pretoria@bigenafrica.com
www.bigenafrica.com

PROJECT TITLE:
GARIEP DAM WATER SUPPLY SCHEME
CONCEPT AND VIABILITY

DRAWING TITLE:
CONTRACTUAL ARRANGEMENT
INTERNAL MECHANISM

MANGAUNG METRO MUNICIPALITY
METSE MUNISIPALITEIT
LEKGOTLA LA MOTSE

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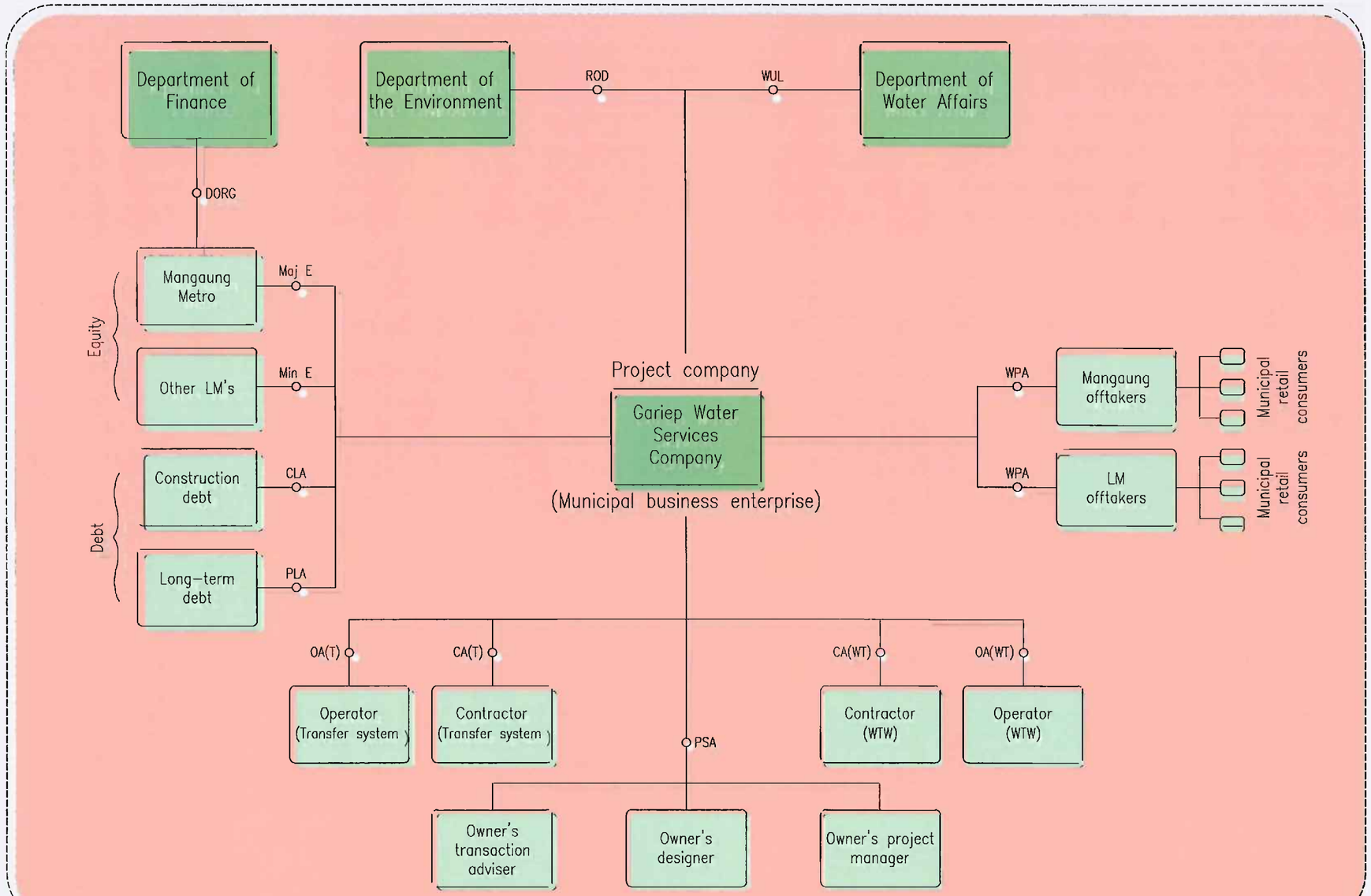
100mm ON ORIGINAL DRAWING

SURVEYED		DESIGNED	P van Heerden
DRAWN	A Steenberg	CHECKED	P van Heerden
ORIGINAL DRAWING SCALE:	ORIGINAL DRAWING SHEET SIZE: A1	CO-ORDINATE SYSTEM:	DATE: May 2015

APPROVED:
CLIENT OR ASSIGNEE: DATE:
CLIENT DRAWING No.: CLIENT REF No.:

APPROVED ON BEHALF OF BIGEN AFRICA:
ENGINEER: DATE:
DRAWING No.: 2485.00.AAA.01.A010
VERSION: A.0

2485.00.AAA.01.A010



LEGEND

WUL	Water use license
Maj E	Majority equity (ownership & control)
Min E	Minority equity (ownership & control)
ROD	Record of decision
CLA	Construction loan agreement
PLA	Project loan agreement
WPA	Water purchase agreements
PSA	Professional services agreement
DORG	Division of revenue grant
CA(T)	Construction agreement (transfer)
CA(WT)	Construction agreement (water treatment)
OA(T)	Operating agreement (transfer)
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ENGINEER: DATE:
DRAWING No.: 2485.00.AAA.01.A011
VERSION: A.0

2485.00.AAA.01.A011