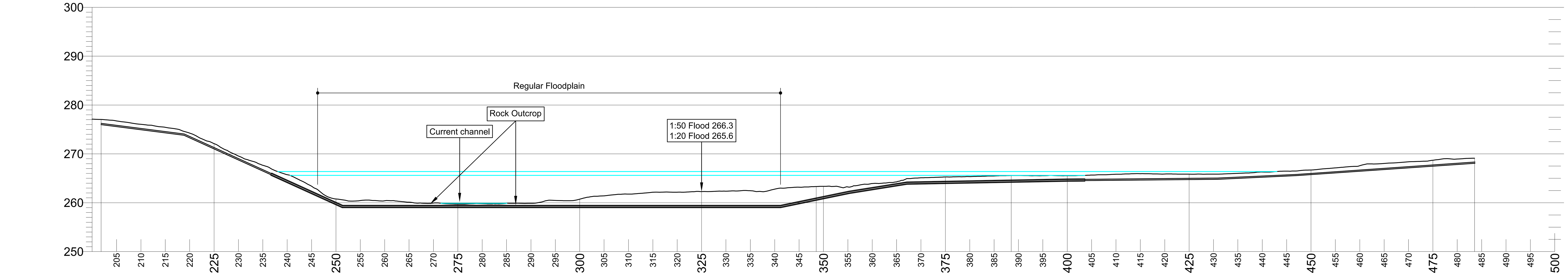

NGL Elevation
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276.05
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272.09
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260.41
260.12
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265.11
265.28
265.35
265.49
265.58
265.53
265.54
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265.83
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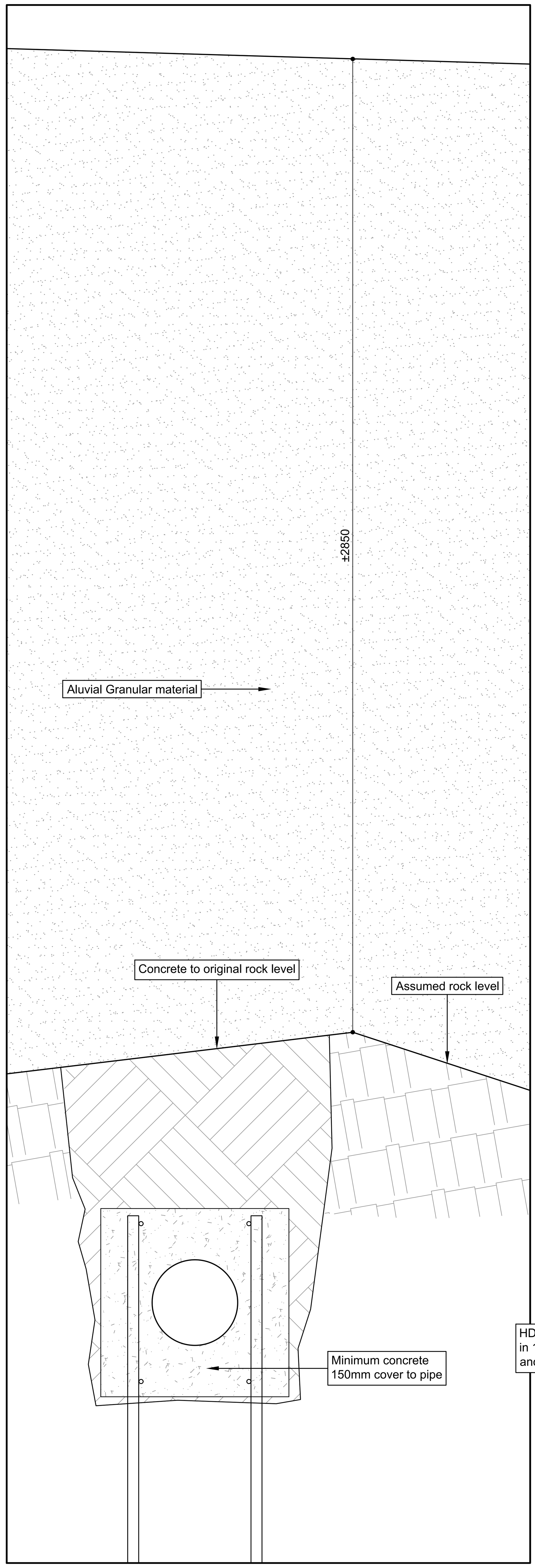
265.88
265.85
265.86
266.01
266.30
266.47
266.71
267.13
267.58
268.04
268.38
268.70
268.95

PIPE	DN200 PVC	218	DN250 STEEL	442	DN200 PVC
BEDDING	GRANULAR	236	RC CONCRETE	404	GRANULAR

SECTION AT CH280
(IN CURRENT CHANNEL)
Scale 1:10



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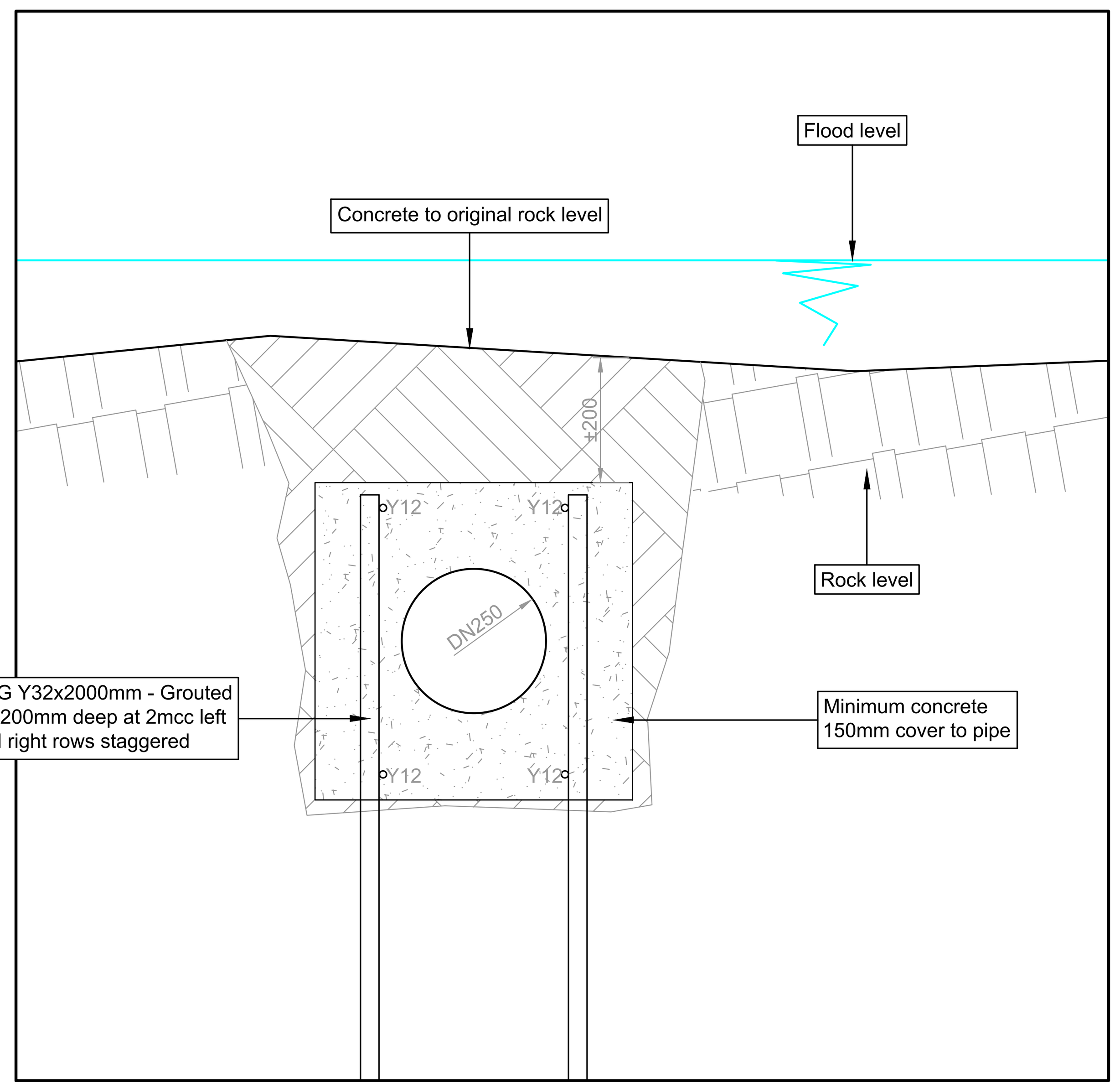

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(IN CURRENT CHANNEL)
Scale 1:10

SECTION AT CH280
(IN CURRENT CHANNEL)
Scale 1:10

0 25 50
50mm on original plan

REVISIONS

Rev	Date	Checked	Description
A	2019-07-09	N.L.	For detail Design

Contract No: -

Client Logo: KING CETSHWAYO DISTRICT MUNICIPALITY

Client Name: | Date: | Sign:

Consultant: EYETHU ENGINEERS Consulting Engineers & Project Managers

Project title:

UPGRADING OF BULK WATER SUPPLY & RETICULATION TO MIDDLEDRIFT SSA3

Drawing title:

MSUZE RIVER CROSSING

Design: J.D.	Date: 2019-07-09	Sign:
Drawn: C.M.	Date: 2019-07-09	Sign:
Checked: N.L.	Date: 2019-07-09	Sign:
Scale: 1:1000	Sheet Size: A0	Sheet: 01 of 01

Project No:	Phase	Stage	Drawing No:	Revision
2142D	PH1	D	5804	REVA

KING CETSHWAYO
DISTRICT MUNICIPALITY

UPGRADING OF BULK WATER SUPPLY & RETICULATION TO MIDDLEDRIFT SSA3

PROJECT RE-ASSESSMENT REPORT

REVISION 0
NOVEMBER 2018

Prepared By:
Eyethu Engineers (Pty)Ltd
P.O. Box 51266
Overport
4067
Phone: (031) 303 7630

EYETHU ENGINEERS
Consulting Engineers & Project Managers

EYETHU ENGINEERS Consulting Engineers & Project Managers PROJECT NO.: D2142	PROJECT:	The Upgrading of Bulk Water Supply and Reticulation to Middledrift SSA3
	TITLE:	Project Re-assessment Report
	DATE:	26 November 2018

PREPARED BY: Eyethu Engineers (Pty) Ltd P O Box 51266 OVERPORT Durban 4067 Tel: (031) 303 7630	PREPARED FOR: King Cetshwayo District Municipality P/Bag X1025 RICHARDS BAY 3900 Tel: (035) 799 2513 Fax: (035) 789 1639
CONTACT PERSONS	CONTACT PERSON/S:
N Loutan	T Mtetwa

SYNOPSIS:
Project Re-assessment / status report

RECORD OF REVIEW

REVISION NO.	REVISED BY	DETAILS OF REVISION	AUTHORISED BY	DATE REVISED
0	J. du Preez	Initial report issue	N Loutan	4 December 2018

QUALITY VERIFICATION

VERIFICATION	CAPACITY	NAME	SIGNATURE	DATE
By Author:	Professional Technologist	J du Preez		
Checked by:	Professional Leader	N Loutan		
Authorised by:	Director	LF Zungu		

Digital Reference:
I:_Eyethu Projects\01_Current Projects\2142D Uthungulu DM Water_2010_Middledrift SSA 3\Admin\05 Reports\02_Design Report\R3_Reassessment Report\Middledrift SSA3 Reassessment Report_2018 11 26.docx

KING CETSHWAYO
DISTRICT MUNICIPALITY

RECORD OF CLIENT REVIEW

Date Received : ....

Status:

Approved ☐ **Clarification required** ☐ **Not Approved** ☐

Comments:

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Signed : ....

Name : ....

Designation : ....

Date : ....

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ABBEVIATIONS / UNITS

KCDM – King Cetshwayo District Municipality

EE – Eyethu Engineers

SSA3 – Sub Supply Area No. 3

WTW – Water Treatment Works

WSA – Water Services Authority

l/c/d – Litre per Capita per Day

1. EXECUTIVE SUMMARY

The King Cetshwayo District Municipality appointed Eyethu Engineers as the professional service providers for the design, construction and implementation of the Middledrift Water Supply Scheme Sub-supply area 3 (SSA 3), in a letter dated 10 June 2010.

This project aim is twofold. To eradicate the water services delivery backlogs in the area and to provide a long-term solution for a continuous supply of potable water to all residents in the area.

This project has gone through scope changes and funding challenges over the past 8 years.

1.1. Location

The project is located in the Nkandla and uMlalazi municipal areas. The project area is approximately 80km^2 in extent with extremely undulating topography, best described as mountainous to hilly with steep sided stream valleys. It is a rural community, where settlements within the Northern and Southern sections are remote and scattered.

1.2. Proposed Works

It is proposed that:

- A dedicated 15km long 200Ø pipeline be constructed to serve as regional bulk supply to SSA3
- The pumpstation mechanical and electrical works at R3-1 be upgraded to 30m^3/hr.
- New reservoirs be constructed at 8 locations from 100kl to 450kl capacity to replace deteriorated infrastructure.
- New bulk mains be constructed of 90Ø to 50Ø pipelines with orifice flow control at branch points.
- New reticulation works be installed ranging from 160Ø to 25Ø pipework for 174km
- 1212_{Y2018} New yard connections with smart meters be installed.

1.3. Funding

The initial funding application for this project in 2011 approved funding for R40 805 279.54. The current 2018 project cost estimate is R530,94 million, refer section 10 for details thereof.

Cost growth is attributed to:

- Changes in the design parameters between the initial briefing and the latest instructions, especially the impact the increased demand requirements had on all aspects of the system.
- Reductions in the amount of existing infrastructure suitable to be incorporated into the proposed regional system. This is mainly due to the:
    - lower level of service that the existing pipelines were designed for, they can thus not cope with the higher demand and more numerous connections; and

- the lack of as-build data to enable accurate assessment to take place.

- Additions to the scope of the works.
    - The application of 'yard connections' vs '200m standpipes'
    - The application of a smart meter at every household.
    - The inclusion of the regional bulk supply line.
- The passage of time and the effect thereof on escalation.

1.4. Cashflow

We have in the cashflow/programme proposal limited annual spending to R60 million. This drives implementation to 11 Phases over 11 years. Implementation is to start in 2019/2020 and be complete in2029/2030.

2. INTRODUCTION

Access to reliable potable water is a key requirement to improve the lives of people. The quality and continuity of water supply benefits their health and wellbeing tremendously.

The King Cetshwayo District Municipality (KCDM) (previously known as uThungulu District Municipality) is the water services authority (WSA) within its area of jurisdiction and is responsible for ensuring effective, efficient, affordable and sustainable access to water for all consumers.

For the Middledrift area a Master Plan was developed and prepared by BKS Consulting Engineers titled '*Master Plan for Water Supply to the Middledrift Supply Area, 2007 Revision'*. The Master Plan was updated in 2016 by Aecom (previously BKS). The Master Plan identified Sub Supply Area 3 as requiring bulk and reticulation works. This project is the outcome of that identification.

KCDM appointed Eyethu Engineers as professional service providers for the design, construction and implementation of the Middledrift Water Supply Scheme for Sub Supply Area 3 (SSA 3).

2.1. Project Brief

In the Letter of Award, dated 10 June 2010, EE was appointed for the bulk services and reticulation. On 15 July 2010 representatives from EE attended a Professional Service Provider's briefing meeting for the various aspects of the Middledrift Water Supply Scheme, held at KCDM.

Copies of the Design Brief: Proposed Middledrift Water Supply Scheme was made available to all professional service providers who attended the briefing meeting. The design brief included information such as the project feasibility report and various data sets such as the ortho-imagery.

The conditions of appointment were outlined in the Letter of Appointment. The required scope of work carried out by EE would be in accordance with the Engineering Council of South Africa (ECSA) Guidelines with an additional Business Plan as agreed by KCDM.

2.2. Implementation History

- Eyethu Engineers was appointed to the project in June 2010.
- In November 2010 the business plan and funding application was submitted for acceptance.
- In February 2011 the then Department of Water Affairs approved the project plan.
- In May 2011 the project was registered on the MIG programme with a R40 805 279.54 budget.
- In August 2012 the Geotechnical investigation was initiated.
- In September 2012 the EIA investigation was initiated.
- In October 2012 the Geotech investigation was completed.
- In October 2013 a Record of Decision from the then KZN Department of Agriculture and Environmental Affairs was obtained for Phase 1 of the project.

- In November 2013 Rev0 of the Design Report was submitted.
- In May 2016 Eyethu Engineers was asked to rework the design to incorporate existing infrastructure of the scattered projects into the overall works.
- In September 2016 Rev 1 of the Design Report was submitted to address the incorporation of the various existing projects.
- In January 2017 the KCDM asked that the design demand be changed from 60kl/c/d to 100kl/c/d and for new smart type meters be installed throughout the scheme.
- In June 2017 Rev 2 of the Design Report was submitted to address the impact of the change in design demand and additional smart water meters.
- In October 2017 a General Authorisation from the Department of Water and Sanitation was obtained for the stream impact of the project.
- Early 2018 Eyethu Engineers was asked to incorporate the Regional Bulk Supply Line into the scope of the project.

2.2.1. Previous Reports

Previous reports were:

2.2.1.1. 'Middledrift Water supply design report' Revision 0

This report was dated 28 November 2013.

2.2.1.2. 'Middledrift Water supply design report', Revision 1

This report was dated 7 September 2016. Additional site visits were conducted indicating that the SSA 3 supply area was plagued with numerous problems due to various reasons described within the report. Upon review of previous designs and assumptions, as well as as-built information, the report recommended a revised design approach whereby a large portion of the existing network would be completely replaced. This was undertaken by determining the total demand, based on a design consumption of 60l/c/d. Where existing infrastructure had sufficient capacity, they were retained and incorporated within the new design.

The project cost estimate as per the previous report was R 75 081 650.28 excluding vat.

2.3. Purpose of this Report

This report develops and supersedes the previous report titled 'Middledrift Water supply design report', Revision 1.

The primary purpose of this report is to:

- Review all base information; and

- To evaluate the impact of the time lag on factors such as population and escalation; and
- To incorporate scope changes into the designs and cost estimates. The most significant thereof being the change in the level of service and the incorporation of the regional bulk supply system.

2.4. Project Objectives

The primary objective of the project is to:

- Provide a reliable supply of potable water to the community of sufficient capacity to provide for a ‘yard connection’ level of service;
- Reduce current and future operation and maintenance (O&M) costs by replacing aging and under capacity infrastructure;
- Promote health and hygiene awareness in the community;
- Uplift the community through the creation of job opportunities during the construction phase;
- Build capacity by promoting community participation;
- Create an awareness of the local government environment and the importance of protecting the supply system.

3. PHYSIOGRAPHY

This section describes the physical attributes of the project area.

3.1. Project Location and Access

The site is located in the Nkandla and uMlalazi Municipal areas. The area boundary is identified as the Nsuze River to the east, uThukela River in the west and the Nkandla Forest to the north as shown on the attached locality plan in Appendix A.

The main project area falls within the Inkosi Magwaza Tribal Authority and Ward 13 of the Nkandla Local Municipality. The regional bulk supply line starts in the uMlalazi Local Municipal area. Co-ordinates to the centre of the project area being 28°49'54 S / 31°01'56 E.

The project footprint covers an area of approximately 85km^2. Villages are remote and are mainly located on hill tops and around sloping areas. The project area comprises of the following settlements:

- Ezimbidla
- Hlwehlewe
- Thuma
- Mzwaneni
- Mthungeni
- Nothekwane

Access is from the east via the P15 off the P50 Eshowe-Nkandla road, from the south via the Kranskop-Middledrift road and from the north west via the P706 Jameson's Drift Road.

3.2. Topology

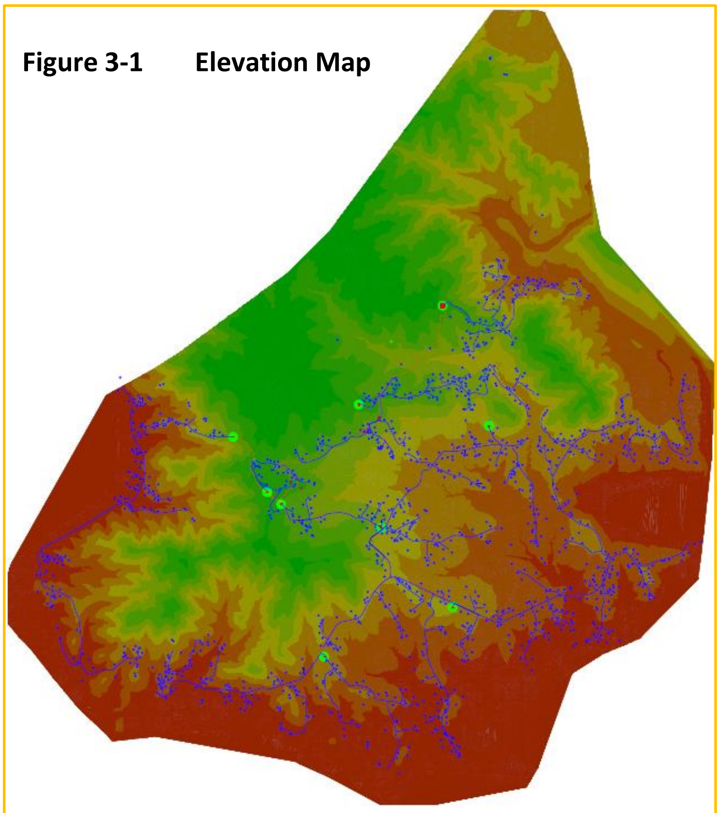
The area is typified by undulating topography. Slope analysis shows that the mean slope is 27%.

The central and northern portions of the supply area can be described as mountainous. There are less steep slopes on some of the valley bottoms. Levels range from 822m.a.m.s.l. at Nsundukazi point (highest point in the area) to 220m.a.m.s.l. at the uTukela River.

3.3. Weather

The area is characterised by hot summers and non-freezing winters. Being in the Thukela valley it does experience humid hot days. Summer highs averages at 29°C, winter lows average 7°C. The area receives upwards of 930mm of rain per annum, rainfall is throughout the year, but with a summer bias.

Figure 3-1 Elevation Map



3.4. Land Use

Land use in the area is largely subsistence agriculture with patches of organised cultivation fields recently developed by the Department of Agriculture. There are no formal town layouts within the area with the only conglomeration of buildings being at the few schools, the clinic and the spaza shops. The mountainous areas above 600m.a.m.s.l. is not inhabited with those areas largely bush grazing.

3.5. Property and Servitudes

All matters relating to the acquisition of servitudes and other property issues would be dealt with independently by KCDM with assistance from EE where needed.

3.5.1. Land Ownership

A search on the Pietermaritzburg Deeds Registration System revealed that this sub supply area is situated on Portion 28 of the Farm No. 15839 Reserve No. 19 depicted on SG Plan No. 390/1994. The registered owner is the Ingonyama Trust.

Preliminary discussions have taken place between EE, KCDM, the Tribal Authority Council and the local Induna. There have been no objections at this stage. The Institutional Social Development (ISD) consultant would still need to meet the Tribal Authority Council and the local Induna to obtain a formal PTO.

3.5.2. Eskom Servitudes

There is a 22kV overhead Medium Voltage (MV) power supply to the area. We also noted pole mounted transformers supplying single phase Low Voltage (LV), supplying the rural residential area. Eskom require 22m wide servitudes for MV power lines.

3.5.3. Existing Roads

The KwaZulu-Natal Department of Transport (KZNDOT) have indicated the following proclaimed roads within project area.

- Provincial Road P706: Tolwane to Jamesons Drift which enters the site in the east and traverses it in a south westerly direction towards the uThukela River. The road then follows the river and exits the site in the west;
- District Road D2242 which is situated in the eastern portion of the site and traverses the site in a northerly direction from the P706 towards the Nsuze River;
- District Road D2233 which is situated in the central portion of the site and traverses the site in a northerly direction from the P706 towards the Nsuze River;
- Local Roads L820 & L2571 which branch off the D2233 and traverse the site further north across the Nsuze river into the Cube Tribal Authority, and in a westerly direction respectively.

KZNDOT have confirmed road reserve widths as follows:

- P706: 30m wide;
- District Roads D2242 & D2233: 20m wide;
- Local Roads L820 and L2571:10m wide.

3.6. Geology

On 9 September 2012, EE appointed Ground Africa Consulting Geotechnical Engineers (GACGE) to undertake a full geotechnical investigation. GACGE completed the Geotechnical Report, which is available upon request from EE, in October 2012.

For the purposes of the geological investigation and reporting, the Middledrift SSA 3 was divided into three sub areas:

- South western;
- Central;
- Northern.

We summarized this investigation report in these three sub areas to facilitate anticipated future phasing of the project construction activities.

Table 3-1 Summarized Geotechnical Results

Characteristic	South Western Area	Central Section	Northern Area
Location	Situated along the northern bank of the uThukela River	Largest study area between the Nsuze River in the east and south, and a ridge of higher terrain to the north	Nsuze River forms north eastern border. Central section situated to the south.
Accessibility	Good accessibility along the well maintained P706 gravel road.	Good road access via gravel roads D2232, D2242, L2820, and L2571;	Poor accessibility with relatively few roads mainly in the south. Roads generally in poor condition. Northern part very steep with no formal roads and was inaccessible by vehicle.
Topography	Topography is hilly with steep sided stream valleys flowing into the uThukela River;	Topography comprises rolling hills with some high ground to the north and west, and a number of deep ravines.	Topography is steeply sloping with sharp ridges of higher ground.
Population and Services	Many homesteads already have piped water.	Area well populated with many homesteads already having electricity and piped water.	Least populated least and developed area. Most of population occupied the southern area. Many abandoned homesteads noted.
Geology	Generally relatively thin unconsolidated colluvial and residual clays and sands over steeply dipping, foliated weathered rock.	Predominantly deep colluvial and residual soil profiles.	Generally relatively thin unconsolidated colluvial and residual clays and sands over steeply dipping, foliated weathered rock.
Hard materials within trench profile	16 out of 25 trial holes	15 out of 42 trial holes	4 out of 16 trial holes

The Geotechnical Engineers deemed the site challenging from a geotechnical perspective due to steep topography and steeply dipping metamorphic rocks and shallow soil profiles.

The impact of the geotechnical aspects relating to various components of the works such as pump stations, reservoirs, and rising mains, are discussed under the relevant sections.

4. STATUTORY FRAMEWORK

The design and construction of a water supply scheme is subject to several pieces of legislation, regulations and guidelines that direct the solution. The more significant thereof are:

Approvals and permissions to be obtained for the work to be done:

- National Environmental Management Act No. 107 of 1998
- Water Services Act No. 108 of 1997

Procedures and processes to be followed for the procurement process:

- Preferential Procurement Policy Framework Act, 2000 (Act No. 5 of 2000)
- Preferential Procurement Regulations, 2017
- Municipal Finance Act No. 56 of 2013
- KCDM Procurement Procedures

Procedures and processes to be followed during implementation:

- Occupational Health and Safety Act No. 85 of 1993
- Construction Industry Development Board Act, 2000 (Act No. 38 of 2000)
- EPWP Infrastructure Guidelines 3rd Edition, June 2015

4.1. Environmental Aspects

Approval is to be obtained from the Department of Environmental Affairs as several of the project actions are listed activities.

Two applications have been made in the past for this project, a Phase 1 and a Phase 2 application, both received approval.

The process to reapply to include the extended scope of the works is in progress. Refer to section 9 for more details on the Environmental Aspects.

4.2. Water Use Licence

A water use licence for impacts to river and stream crossing is required. A general authorisation by the Department of Water Affairs has already been obtained for the bulk of the works. It is attached hereto as Appendix B. Additional stream impacts by the expanded scope of work will be applied for as part of the environmental process.

5. DESIGN PARAMETERS

5.1. Guideline Documentation

The following standard design guidelines would be adhered to for the design and sizing of infrastructure components:

- DWA RDP Rural Water Supply Design Criteria Guidelines;
- MIG Basic Level of Service and Unit Costs: A guideline for Municipalities;
- Guidelines for the provision of engineering services and amenities in residential township development.

5.2. Project Specific Design Parameters

5.2.1. Demand Parameters

Design Level of Service:	Yard Connections
Design Water Usage (DWU):	82.6 l/c/d
Design occupancy:	6 people per household
Annual average daily demand (AADD):	DWU x Population
Gross annual average daily demand (GAADD) :	AADD x LF
Fire Flow:	Excluded

5.2.2. Design Horizons

Bulk supply pipelines	20 years
Reticulation pipelines	20 years
Reservoirs	20 years
Water treatment works	20 years

5.2.3. Flow Rates

5.2.3.1. Reticulation

Loss factor (LF)	15%
Design Peak Factor (DPF)	4
Design Peak Flow Rate:	DPF x GAADD
Minimum Rate:	1.5l/min

5.2.3.2. Bulk Supply Pipelines

Summer Peak Factor (SPF):	1.5
Design Peak Flow Rate:	SPF x GAADD
Rising mains:	16/18 hours pumping period.

5.2.4. Storage volumes

Reservoir Storage	
Pumped from One Source:	48 hrs x AADD
Pumped from Multiple Sources:	36 hrs x AADD
Supplied by Gravity Source:	24 hrs x AADD
Break Pressure Tanks:	5 minutes per side
Elevated Tanks:	4 hrs x AADD

5.2.5. Pressures

5.2.5.1. Reticulation Residual Pressures at yard standpipe

Minimum: 10 m where possible.
Maximum Static: 90 m below free water surface
Flow limiters to be installed on stand pipes when Residual Pressures are greater than 25 m above GL.

5.2.5.2. Bulk Distribution non-metal pipelines:

Minimum: -3 m
Maximum Static: 200 m below free water surface

5.2.6. Pipeline velocities

The following maximum and minimum pipeline velocities are used as guideline figures for design:
Typical Target velocity: 1,0 m/s
Minimum Raw water: 0,6 m/s,
Minimum Treated water: 0,3 m/s,
Maximum DPFR for Reticulations: 1,5 m/s,
Maximum Pump suction inside station: 2,0 m/s,
Maximum Design flow in Bulk Supply: 3,0 m/s,
Maximum Scour flow in Pipelines: 5,0 m/s,

5.2.7. Pipeline Materials

The basic principle would be to only use materials complying with SANS or BS standards, as well as to use standardized equipment recommended by the Employer. The recommended guidelines for material are contained in Table 5-1 below.

Table 5-1 Pipeline Material Guidelines

Materials/ Fittings	Specification	Comments
HDPE pipe	SANS 4427	PE80 PN10 minimum Up to 63mm diameter
PVC-U pipe	SANS 966-1	Class 9 minimum Standard diameters 75mm – 250mm (excluding 125mm and 140mm)
PVC-M pipe	SANS 966-2	Class 20 & 25 only where economically viable. Standard diameters 75mm – 250 mm (excluding 125mm and 140mm)
GMS Pipe	SANS 62-1 SANS 62-2	Typically for 50mm – 150mm diameter Grooved ended, hot dip galvanised - Klambon.
Steel Pipe	SANS 719 SANS 1182 SANS 1123	Typically for > 400mm diameter or high pressure applications or may be used above ground to avoid excavating through hard rock or stream and donga crossings
Ductile Iron Pipe	BSEN 545: 2010	Typically for > 300mm diameter or high pressure applications Coatings and linings as per spec.

5.2.8. Pipe friction factors

Only Darcy-Weisbach formulae (with friction factor, determined using Moody diagram or Colebrook-White formula); or Hazen-Williams formula, with C factor equivalent to k_s for pipe diameter and velocity, are acceptable for design. The pipe friction factors are given in Table 5-2.

Table 5-2 Pipe Friction Factors

	Pipelines (excl. fittings losses)	**Reticulation** (incl. fittings losses)
uPVC	0,06 mm	0,10 mm
Steel (cement mortar lined)	0,20 mm	0,26 mm

(Absolute Roughness, ks, mm)

5.2.9. Depth of pipe cover

The minimum depth of cover to pipelines is:
Generally: 600mm
Under cultivated land: 900mm
In Road Reserves: 1000mm
Road/Railway crossings: 1200mm
Additional protection should be provided to pipes under roads or railways where required.

5.2.10. Vacuum pressures

Vacuum pressures in bulk supply pipelines during shutdown and scouring of pipes are generally unacceptable, but -3m maximum is acceptable to economise on Double Orifice Air Valve installations.

5.2.11. Trench width

To compliment LIC work side allowances are adjusted. Allow for at least the pipe diameter plus 150mm on both sides for small diameter pipelines to ensure that backfilling can be effectively compacted. The minimum trench width should be 600mm for pipes up to 110mm dia. 700mm for pipes up to 160mm, 300 side cover for pipes over 160mm diameter.

5.2.12. Bedding and backfill (including material)

According to SANS 1200 LB and DWS 1110.

5.2.13. Slope

A slope of steeper than 0,3% is required for the pipeline to avoid the forming of air pockets in the pipeline.

5.2.14. Water meters

Schemes should be provided with bulk metering from the water source.

All stand pipes should be metered. Where house or yard connections are provided, the consumption of each individual household should be metered using Smart meters.

5.2.15. Pipe markers

Pipe markers are required at a minimum spacing of 500m unless the pipeline follows a road. All bends should be marked.

5.2.16. Air release and air intake valves

Air valves should be provided on summits of mail lines.

Air intake valves are required upstream and downstream of isolation valves on ascending and descending pipeline slopes respectively.

The minimum distance between air valves should be 500m. Separate isolating valves are required on each air valve branch for maintenance purposes.

The diameter of the branch below an air valve should be as follows:

- Pipeline =< 200 mm NB: Install an equal T piece below the air valve.
- Pipeline > 200mm NB: The branch pipe must be as large as practically possible with a maximum diameter of 600mm NB for all pipelines larger than 600mm NB.

5.2.17. Scour valves

Should be provided at all low points. Scour valves should be sized that the pipe can be drained between the isolating valves within 2 hours.

The diameter of the drainpipe should be a minimum of 0.4 times the diameter of the main pipe but should be an equal T for pipelines =< 200mm NB.

5.2.18. Isolating valves

Should be placed:

- At all pipeline intersections in the branch and main line.
- At an approximate maximum distance of 1,5km apart, preferably at the lowest points.
- Start of every rising main with arrow pointing towards the pumping station.
- At the end of every gravity main with arrow on valve pointing in flow direction.
- Isolating valves should be mounted with flange adapters to aid in removal.

5.2.19. Valve chambers

Valve chambers of robust construction should be provided for all valves. Valve chambers to be properly ventilated with vermin proof fixed GMS or 3CR12 louvered ventilators. Sufficient access should be provided in valve chambers for the removal of bolts.

The cover should be 700mm above ground level and should be of a hinged and non-removable type. A sump should be provided for dewatering. The chamber should be protected against vandalism.

5.2.20. Pressure control valves

The use of break pressure tanks instead of pressure control valves is recommended by DWA in order to reduce pressures where it cannot be achieved by the correct placing of reservoirs.

5.2.21. Thrust blocks and anchors

Coupled pipelines must be anchored at:

All changes of direction greater than 10 degrees.

At changes in pipe size.

At slopes greater that 1:6.

At blank ends.

The anchor blocks must be large enough to:

Provide sufficient friction and bearing forces between the anchor block and soil to balance the thrust force in any direction; and

Balance upward forces through the mass of the block.

The pipe should be imbedded at least up to the centre line at bends. A flexible membrane should be inserted between the pipe and anchor block to prevent damage to pipes subject to chafing.

5.2.22. Pipeline Specifications

The following DWAF specifications are applicable to pipelines and are included in the Specifications Folder.

Number	Description
DWS 1110	Construction of pipelines
DWS 1130	Design, manufacture and supply of steel pipes
DWS 1131	Lining and coating of steel pipes and specials
DWS 1140	Design, manufacture and supply of asbestos-cement pressure pipes and joints
DWS 1150	Glass reinforced plastics (GRP) pipes and joints for use for water supply
DWS 1160	Design, manufacture, supply, and installation of Polyvinyl Chloride (PVC) Pressure Pipes and fittings
DWS 2510	Supply of valves

5.2.23. Pump Stations

The following steps should be followed to select the correct pump duty:

The system curve, relating to the hydraulic head lost in the system for different flows, to be calculated and plotted as a graph above the required static head. Pump Station losses, including those of all valves in the pump line, should be included in the calculation of the system curve.

The pump performance curves to be plotted on the same graph. If more than one pump is required then these are added either in series or in parallel, as required. The pump curves would intercept the system curve at the demand duty point, or a more favourable point.

An ideal pump selection would result in each Pump Duty Point falling at or very near to the pump Best Efficiency Point.

When only one pump in a multi-pump arrangement is operating, the intercept with the system curve would be at a point of reduced head and increased flow with regard to the chosen Pump Duty Point. Care should be taken that the motor is not overloaded under the one pump condition, and that a margin of at least 15% in excess of the power that the pump would demand is available under the worst possible operating condition.

5.2.24. Pump standby capacity

For Borehole Pump Stations:

- No standby pump capacity is required, but a minimum of 2 boreholes must be equipped for a village.

For Reservoir supply pump stations:

- Duty and Standby pumps are required.

5.2.25. Reservoirs

It is recommended that all reinforced concrete water-retaining structures be designed to a 0.2mm crack width using 30MPa concrete in accordance with BS8007.

Potable water storage structures must have a roof. Storage must be provided for sludge accumulation and a scour valve must be provided. The scour pipe should be separate from the inlet or the outlet pipe.

Submerged valves and fittings must be avoided if possible. Pipework below the reservoir floor should be minimized.

A screen should be provided at the outlet.

The selection of materials would be dictated by durability and life cycle costs.

Bulk metering would be essential to enable proper management of the scheme.

The reservoir should not be capable of spilling under normal operating conditions. A water level indicator should be provided.

The reservoir should be provided close to consumers to avoid long pipelines having to cater for the instantaneous peak demand.

5.2.26. Break pressure tanks

Correctly placed reservoirs are preferred over Break Pressure Tanks, but when this is not practical, the following guidelines would be applicable to break pressure tanks:

Tanks to have a partition with duplicate pipework and control valves etc.

The minimum volume per partition:

- Gravity inflow and outflow – 5 minutes
- Pumped inflow and/or outflow – 30 minutes

Inlet control:

- Gravity – Float Level Control
- Pumped – as per pump control

Control Valves are not preferred unless they are unavoidable and then provision must be made for adequate maintenance.

6. NEEDS DETERMINATION

Needs determination for water supply schemes are driven by user types and quantities, which in this case is largely domestic use. There are 4 schools and 1 clinic within the sub supply area. Each school will be provided with a smart meter and yard connection, the clinic has it's own elevated tank that will be connected to the network via a smart meter. There are no commercial / industrial users present within the project footprint. Agriculture within the area have developed their own water supply from the local rivers and will thus not be considered. They will however have to be considered in the next regional master plan as they would have a large impact on the level of assurance from the rivers.

6.1. Demographics

6.1.1. Current Population

The current population figures were obtained from a desktop household count conducted in October 2018 using the latest Google Earth satellite imagery (2017/2018). An average household occupancy of 6 people per household has been used in accordance with the standard DWA design criteria. The total Y_{2018} population for SSA3 is estimated at 7 272.

Various sets of data were compared to verify the population count for the water supply scheme. The 2016 Masterplan indicated a Y_{2015} count of 6 298 for SSA3 which if escalated at the rates as suggested by the 2016 Masterplan gives a Y_{2018} count of 6 489. 6 489 is a 8% undercount compared with the recent count of 7 272. The impact of this is significant as the current sizing of the Regional Bulk Supply pipeline depends on data provided by the 2016 Masterplan for sub supply areas 1 and 4. Updated aerial photography is being procured for SSA 1, 3 and 4 areas where population counts needs to be verified. In addition, the ISD activity that is currently in action will conduct a verification process of the population numbers for SSA3.

6.1.2. Growth Projections

The household count from the 2010 orthographic images and the 2017/2018 Google Earth images were compared to determine growth rates for SSA1. Each household was digitally mapped and classified as static, new or abandoned. The results of the mapping are:

- 1 016 Static Households
- 131 Abandoned Households
- 196 New Households

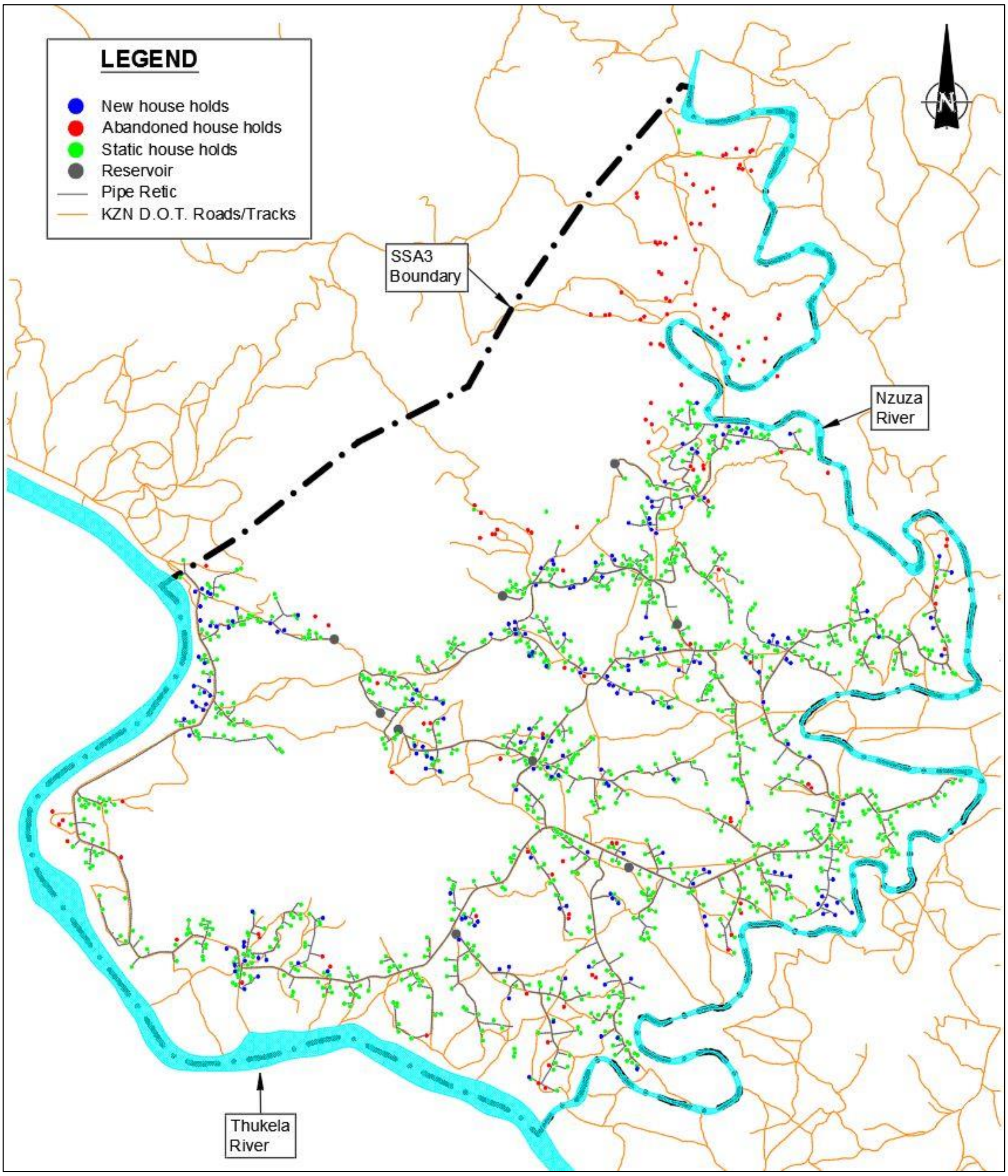
Overall then 1 212 Households

Comparing 1 147 households in 2010 and 1 212 households in 2018 a growth rate of just less than 0,7% per annum is found. The suggestion from DWA and from the 2016 Masterplan is to apply an 1% growth projection for the area.

Using the 1% per annum anticipated growth rate we estimate 1 478 households for the 20-year horizon and 1 634 households for the 30 year horizon.

Interestingly the entire area previously known as Zone 11 was abandoned except for 2 households on the far north of the area.

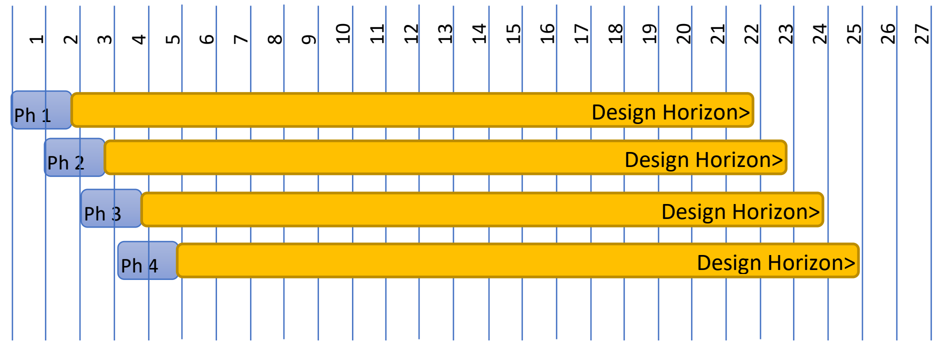
Figure 6-1 Household Distribution Change



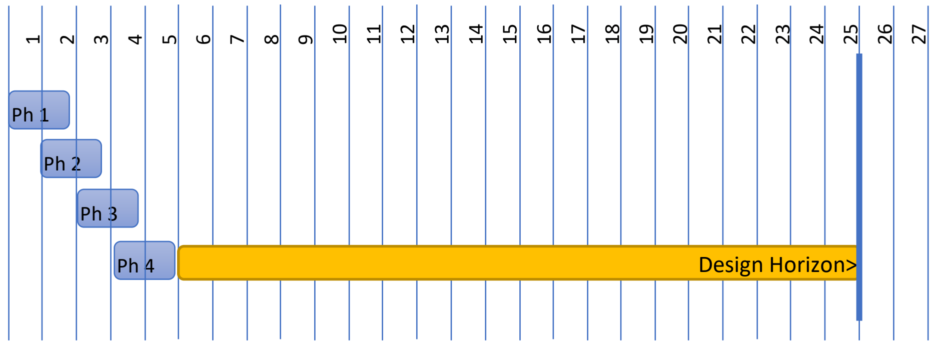
6.1.2.1. Application/Implication of growth projections

The growth projections will be used to determine future water demands. Regarding the phasing of the project there are two ways of applying design horizon that can be utilised.

It has to do with what demand target are applied to the components in each phase of the work when they are expected to be completed over several years/phases. In Method A, the components in each phase of the works is sized for the estimated demand at the end of the design horizon from when construction for that phase is done. (year 22 for phase 1 and year 25 for phase 4 in the example below) In Method B the entire system is sized for the design horizon of the last phase. (year 25 in the example below)



Method A



Method B

The method used can have far reaching implications. In this project for example Method B would add 11 years to design horizon of the regional bulk supply line, this could effectively increasing demand to the point where a 250Ø pipe is needed as opposed to the 200Ø that would be needed for the Method A application. The application in the remainder of this report is of Method A.

6.1.3. Projected Population

The projected population for each reservoir zone is indicated in table Table 6-1. The overall population for Y_{2040} is 9 052 and for Y_{2050} is 9 999.

Table 6-1 Projected Population Counts per Reservoir Zone

Reservoir zone	House-holds	Base year	Projected Population											
		2018	2040[1]	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050[2]	2051
3-1	287	1722	2143	2165	2186	2208	2230	2253	2275	2298	2321	2344	2368	2391
3-2	50	300	373	377	381	385	389	392	396	400	404	408	412	417
3-3	37	222	276	279	282	285	288	290	293	296	299	302	305	308
3-4	151	906	1128	1139	1150	1162	1174	1185	1197	1209	1221	1233	1246	1258
3-5	149	894	1113	1124	1135	1146	1158	1170	1181	1193	1205	1217	1229	1241
3-8	292	1752	2181	2203	2225	2247	2269	2292	2315	2338	2361	2385	2409	2433
3-9	153	918	1143	1154	1166	1177	1189	1201	1213	1225	1237	1250	1262	1275
3-10	93	558	695	701	709	716	723	730	737	745	752	760	767	775
Total	1212	7272	9052	9142	9234	9326	9419	9513	9608	9705	9802	9900	9999	10099

[1]*Design Horizon for when first phase is expected to be completed.*

[2]*Design Horizon for when last phase is expected to be completed.*

6.2. Water Demand

Table 6-2 below indicates the estimated water demand for the estimated population based on the population counts and growth rates discussed above, and the required level of service indicated in section 5.2.1.

Table 6-2 Peak Annual Demand

Reservoir zone	Peak Gross Annual Average Demand[1]												
	2018	*2040*[2]	*2041*	*2042*	*2043*	*2044*	*2045*	2046	2047	2048	2049	2050[3]	2051
3-1	258	322	325	328	331	335	338	341	345	348	352	355	359
3-2	45	56	57	57	58	58	59	59	60	61	61	62	62
3-3	33	41	42	42	43	43	44	44	44	45	45	46	46
3-4	136	169	171	173	174	176	178	180	181	183	185	187	189
3-5	134	167	169	170	172	174	175	177	179	181	183	184	186
3-8	263	327	330	334	337	340	344	347	351	354	358	361	365
3-9	138	171	173	175	177	178	180	182	184	186	187	189	191
3-10	84	104	105	106	107	108	109	111	112	113	114	115	116
Total	1091	1358	1371	1385	1399	1413	1427	1441	1456	1470	1485	1500	1515

[1]*Applying 86 l/c/d , 15% losses, 1,5 Summer Peak Factor. All values in kl/day.*

[2]*Design Horizon for when first phase is expected to be completed.*

[3]*Design Horizon for when last phase is expected to be completed.*

7. SSA3 WATER SUPPLY SCHEME

7.1. Water Source

Two possible sources of supply for SSA3 exist that are sufficient to meet the entire area's demand.

- The Nsuze River
- The Thukela – Mhlatuze Transfer Scheme

Additional minor sources are several boreholes and/or springs that use to feed small networks. The DWAF borehole database for the area was sourced and the details thereof is included in Appendix C. The borehole yields are not sufficient for the demand and will not be considered further. The WSA can obviously still utilise these for emergency supplies.

7.1.1. Nsuze River

A potential abstraction point from the Nsuze River at a point 360 m.s.l was mentioned in the 2007 Master Plan in Fig 3, on Pg. 18. This abstraction point would have a yield of 3.7 Ml/day. The preliminary desk top study suggested reliability, but that would need to be confirmed by further and detailed investigations, which is not warranted at this time as a reasonable alternative is readily available in the Middledrift WTW.

There is a current abstraction works on the Nsuze river where a well in a sand bank was utilised to abstract river water, treated through a small dosing plant and pumped to the command reservoir at R3-1. This well was damaged in floods and since then the operations team draws water directly off the river, which can only be done in still/clear flow periods as there is no suitable filtration system at the abstraction works to deal with turbidity after storms. This works is used as augmentation to the supply from the Middledrift WTW.

Further upstream the Zimbidla Pump station use to abstract from the Nsuze river to the R3-10 reservoir site. This unit is not operational.

7.1.2. Thukela – Mhlatuze Transfer Scheme

The Middledrift WTW is supplied from a branch off the Thukela – Mhlatuze transfer scheme. The ultimate source of the water is the uThukela River which as the largest river in the province has more than enough yield for the Middledrift scheme. The transfer scheme is currently being upgraded and has more than enough capacity for the Middledrift scheme. The transfer scheme is operated by Mhlathuze Water on behalf of DWA. Data from the masterplan indicates the capacity of the parts of the water supply route to SSA3 as follows:

Table 7-1 Raw Water Capacity

Part	Description	Current Capacity	Demand Area	Y_{2018} need	Y_{2040} need	Status
Source	uTukela River	1.2 m^3/s or 103 Ml/d	Mhlatuze /Goedetrou and Middledrift systems			
Abstraction	uTukela river works					
Raw water transfer	High lift pump station – Madungulu					
	Raw water rising main Madungulu to Mkhalazi					
Takeoff	Branch off from high lift pipeline		Middledrift system	5.5 Ml/d	20.2 Ml/d	
Treatment	MIddledrift WTW	9.6 Ml/day				Currently OK– Future upgrade req.
Distribution	Regional Bulk Supply	0.3 Ml/day	SSA 1, 3 & 4	2.2 Ml/d	2.8 Ml/d	Under capacity

7.2. Treatment

The water supplied to SSA 3 is to meet the quality standards of SANS 241 (Specifications for Drinking Water).

The Middledrift WTW can supply water to this standard. Records to this effect still need to be obtained to verify the compliance. Visual observations during site visits indicate that the requirements are being met. The control system at the treatment works is highly automated and probed giving a high confidence that the good quality of water will remain so.

The treatment works capacity of 9,6 Ml/d is currently acceptable but with several expansions to the distribution schemes planned it will be under capacity in the near future. Refer to Appendix D for details on the Middledrift WTW demand projections.

No immediate work at the treatment works is proposed.

7.3. Regional Bulk Supply

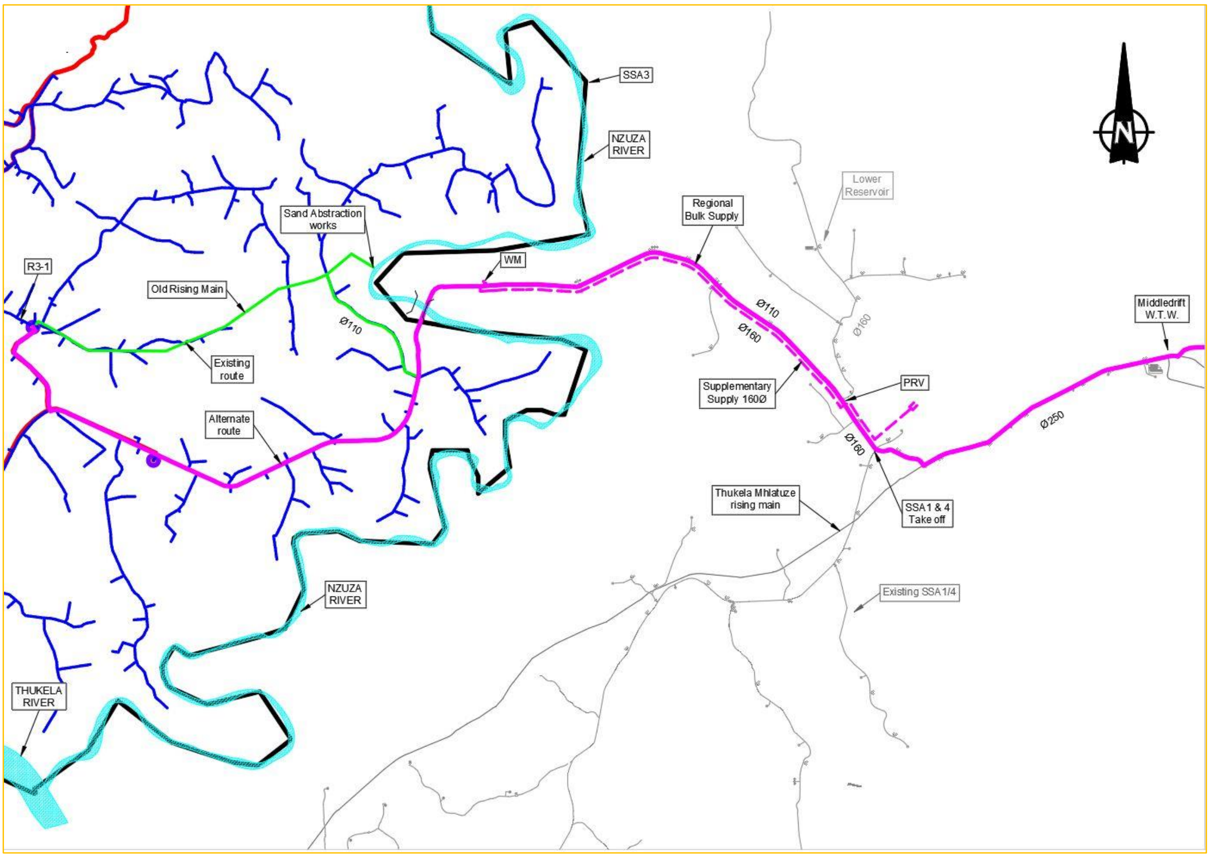
The regional bulk supply to SSA3 is via a gravity pipeline that leads from the Middeldrift WTW clearwater reservoir to reservoir R3-1 in SSA3. The pipeline serves SSA1, SSA3 and SSA4.

7.3.1. Existing Pipeline

The pipeline consists of various parts that were developed and expanded over the years.

At the clearwater reservoir a 250Ø line is connected to the reservoir outlet manifold and follows the Thukela-Mhlatuze transfer pipeline route up to chainage ±3+080 near the P706/P15 intersection, where it turns to follow the P706. It is at this intersection where the takeoff to SSA1&4 occurs as a 200Ø branch at ±3+600. From the SSA1&4 takeoff the regional bulk supply line continues as a 110Ø line (plans indicate a 160Ø here, but the operators assure us it is 110Ø) along P706 to the point where the bulk meter for SSA3 is located at ± 8+350. The initial work to the line stopped here.

Figure 7-1 Regional Bulk Supply Map



The line was later extended as a 160Ø pipe, over the old Nsuze river bridge, reduced to 110Ø once across the river and turned north at the Kwamanqondo school at ±9+750 and after about 1,4km linked to the old rising main that ran from the sand abstraction works for 3,2km through the bush to reservoir R3-1. At the link to the old rising main, simple controls were put in place to allow the operators to select supply to R3-1 from the regional bulk supply or from the abstraction works. Indications are that the old rising main is a 110Ø line, but this has not been verified.

The regional bulk supply pipeline did not provide the expected water to R3-1 as initially planned. This is mainly due to the pipeline also serving various small offtakes along the route, acting as a reticulation distributer rather than a bulk main. Also, there is not sufficient hydraulic advantage on this route to serve reservoir R3-1 through a 110Ø pipeline. There is only 60m height difference between the start and end points over a 15km long route.

With the poor functioning of the regional bulk supply pipeline the system was augmented by the extension of a 160Ø pipeline from a lower reservoir running parallel to the 110Ø pipeline from the SSA1&4 takeoff to the water meter. The new 160Ø is then joined near the water meter and the old 160 proceeds across the river. Operation staff indicated the impact of this as minimal. This is understandable as the pressure driver for the regional bulk line is at a higher elevation than the reservoir driving the new 160Ø pipeline.

Road P706 is currently being upgraded and as part of the upgrade the bridge over the Nsuze river was upgraded and the regional bulk supply line routed to cross the new bridge. The bridge work included a ducted section in the sidewalk for the pipe. It was laid in as a 160Ø PVC type pipe. Once connected it continuously leaked. Eventually operational staff bypassed the in-walkway line with a 110Øcl20 HDPE line slung to the downstream soffit of the sidewalk. Other than this bridge section the class of pipework used in the rest of the line is not known.

Analysis of a crude model of the existing arrangement shows that the expected flows at R3-1 is 360kl/d and the pressure at the SSA1&4 takeofff is in the order of 34m. This correlates with the operator's comments that it takes them a day to fill the 300kl R3-1 reservoir.

7.3.1.1. SSA1&4 Takeoff

The 200Ø takeoff to SSA1&4 feeds a reticulation system directly, i.e. it is not a bulk system, there is no reservoir to act as 'the supply' to SSA1&4, it draws directly off the treatment works clearwater reservoir. The clearwater reservoir is thus the pressure reference for the SSA1&4 system. Any change in flow on the regional bulk line before or after the takeoff will influence the pressure head at the takeoff, this in turn will influence the users linked on the line in that they will experience flow changes. Dropping the takeoff pressure too low (by improving the flow to SSA3) will likely create negative pressures lower down in the SSA1&4 system.

7.3.2. Options Evaluated

It is planned that the bulk supply be constructed in 2019/2020, the design horizon for this pipe is then 2040. If supplying SSA1,3&4 the Y_{2040} demand is 4 506Ml/d. The Y_{2040} demand for only SSA3 is 1 333Ml/d.

7.3.2.1. Pumping the existing pipeline

The line was analysed as is with the demands to SSA 1, 3 and 4 as per the 20-year horizon. A in-line booster pump type of system equal to ±325kW would be required to force the demand through the existing line. The pressures involved would exceed the pressure rating of virtually the entire pipeline as installed which negates this option.

7.3.2.2. Pumping a 160 pipeline

An alternative was evaluated where the section from the SSA1&4 takeoff, all the way to R3-1 was upgraded to a 160-diameter line and again pumped. The results were that a 50kW pumping solution should work. Again, the existing 250Ø line would be over pressurised. The new portion would mostly be class 25 pipework with about 4km of steel pipeline required leading into and from the river crossing.

7.3.2.3. New gravity pipeline

Options were evaluated for new gravity lines to R3-1. Two scenarios were investigated with various diameters for each scenario.

- new pipework only from the SSA1&4 takeoff to R3-1 i.e. leaving the 250Ø line in place and taking flow to SSA1&4 into account.
- new pipework all the way from R1-1 to R3-1 i.e. placing a new dedicated line for SSA3 and not linking to SSA1&4 but leaving those areas on the old 250Ø line.

7.3.3. Summary Discussion

Results of the various options analysed is presented in

Table 7-2 below.

Table 7-2 Results for Regional Bulk Options

Diameter evaluated	Areas served	Flow at R3-1	Pressure at SSA1&4 takeoff	Comment
		kl/day	*m*	
250 + 110	SSA 1, 3 & 4	340	34	Current arrangement
250 + 160		935	29	Insufficient flow to SSA3
250 + 200		1550	23	Acceptable flow, head at takeoff is 11m (110kPa) less than current.
250 + 250		2422	14	Insufficient head at takeoff
160	SSA 3 Only	1074	N/A	Insufficient Flow to SSA3
200		1900	N/A	Acceptable flow to SSA3
250		3525	N/A	Acceptable flow to SSA3

Any option with a 110Ø or 160Ø is not suitable.

The only viable options then are those involving a 200Ø or 250Ø line to R3-1.

Aspects regarding the first scenario are:

- Negative impact to SSA1&4 system in that less pressure head would be available at the takeoff to drive the SSA1&4 downstream system.
- Negative aspect if this scenario is implemented there will remain users directly on the bulk line.
- Costs are less as a shorter section of pipe is constructed.

Aspects regarding the second scenario are:

- Positive impact to SSA1&4 in that the pressure head at the takeoff will increase thus improving the flow towards SSA1&4.
- Positive impact in that the line will be a dedicated bulk line
- 3,6km of additional pipework is required for this scenario.

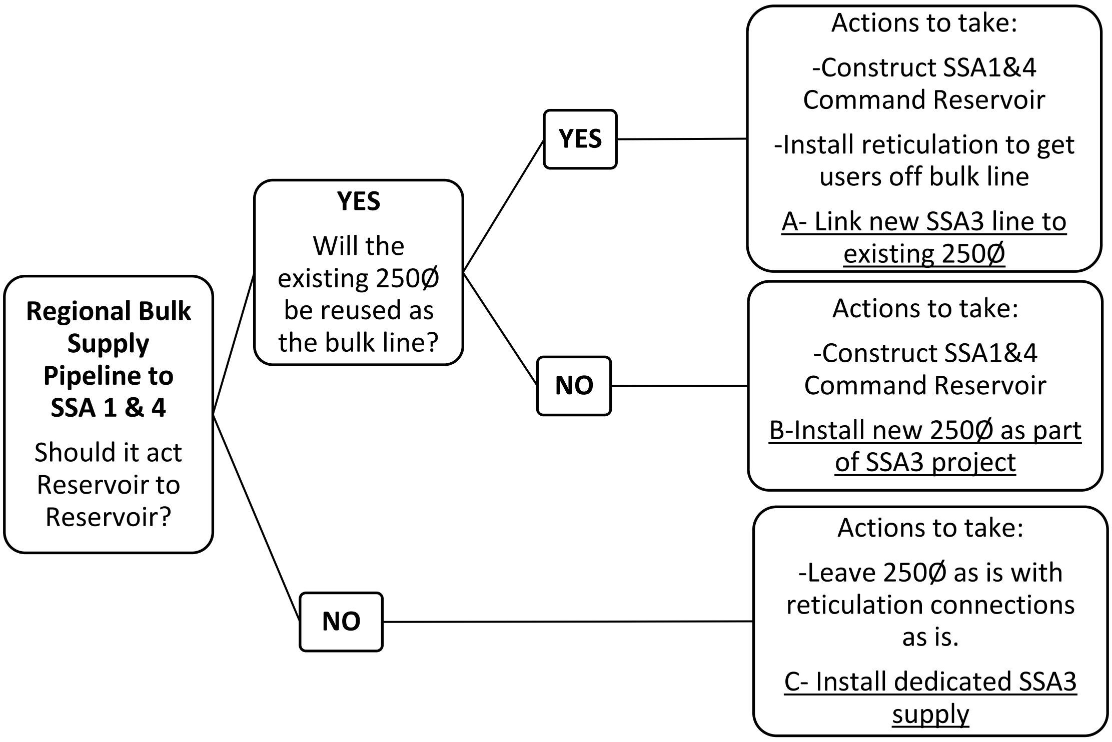
The time sensitivity of the dedicated line must be considered. Assuming the level of service, the population growth rate remains as per the base assumptions of this report then:

- The 200Ø at 1900kl/d capacity should be sufficient until Y2073
- The 250Ø at 3525kl/d capacity should be sufficient until Y2135

7.3.3.1. Operational Preferences

This following section is slightly outside of scope of this project, but the Water Service Authority's preference in this does influence the action choice for the first section of the regional bulk supply pipeline. Actions marked A, B and C impact this project. In the function as regional bulk main this pipeline should be a 'reservoir to reservoir' pipeline, not directly supplying any users. As described above this is not the case for the current line. For this installation there are a few scenarios for improving/correcting it, if it is even desirable to improve it. The reuse of existing infrastructure becomes a factor in each scenario. Below is a decision flow chart that will guide what impact the WSA's preferences will have.

Figure 7-2 RBS Decision Flow Chart



7.3.4. Proposed Regional Bulk Supply

We propose to proceed with the dedicated 200Ø gravity main from the treatment works clearwater reservoir to R3-1.

We believe this proposal

- provides enough flow capacity; and

- does not influence the existing users on the SSA1&4 takeoff line; and
- achieves the objective of providing a dedicated bulk line.

7.3.5. Route Issues/Impacts

7.3.5.1. Routing

The route is likely to run right next to the existing lines to lessen the impact on homesteads near the line.

Whereas the current line turns at Kwamanqondo school and proceeds towards the old sand abstraction rising main and 3,2km through the bush, it is proposed that the new line will run along the P706. This is done to improve access to the line. This route selection adds 0,7km to the route.

7.3.5.2. Pressures

At the Nsuze river and the next valley, severe pressures are encountered >2000kPa. The use of Klambon type pipe for this section is likely.

7.3.5.3. Road crossings

The route crosses provincial roads several time.

There is apparently a dedicated culvert where the Thukela-Mhlatuze line crosses the P15, the new pipe will use the same route.

The road crossing at the P15/P706 intersection is likely to be by pipejacking as the road is surfaced.

The 2 road crossings along the P706 are currently gravel surfaces. They can be cut and covered, but there is a chance that the road may be upgraded by that time, in which case the work will be pipejacked.

7.3.5.4. The Nzuse River bridge

Use should be made of the ducting provided in the sidewalk. Failing which a steel line is to be bracketed to the downstream side. Discussions with DOT will guide the solution here.

7.3.5.5. Environmental Issues

There is not likely to be any severe issue with this route. It will be part of the scoping process currently underway.

7.4. Storage Reservoirs

The existing and proposed networks within SSA3 are dispersed with several reservoirs located at high points, each feeding their own network.

Reservoir sizing was based on the future annual average daily demand (AADD) of the villages according to standard DWA guidelines. Site visits were conducted to determine the existing positions, sizes, conditions and accessibility of existing reservoirs as well as any other constraints, to establish whether they were suitable to be incorporated into the new scheme.

7.4.1. Reservoir 3-1

The existing reservoir has a capacity of about 300kl, is situated at an elevation of approximately 416m and receives water via the regional bulk supply pipeline. The reservoir is of ferro cement construction and is deteriorating beyond economical repair. The fence remains in place and secure.

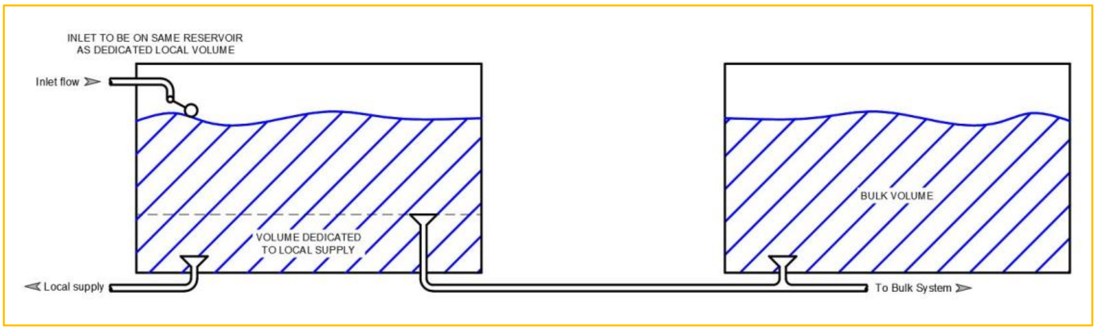
7.4.1.1. Capacity Determination

This reservoir will supply water to a Y_{2018} count of 287 households. This equates to a direct storage requirement of 202kl. It further serves as the command reservoir for the entire system and thus requires and additional 650kl storage. Total capacity required 852kl.

7.4.1.2. Proposed Works

It is proposed that this reservoir be upgraded in two steps. Each step being 450kl of new storage. The first new reservoir is to be constructed while the existing pumping system operates of the existing reservoir, then the pumping operation is to be connected to the new reservoir. Once the pumping system operates from the new reservoir the old reservoir can be demolished and the second new reservoir be constructed and linked with the first. One of the new reservoirs will require a dedicated outlet for the local village so that the bulk system does not overdraw on it.

Figure 7-3 Schematic of arrangement for dedicated local supply



7.4.1.3. Road Access

The access is from the existing gravel road L2571 off gravel road D2232. This is an informal short overland section trough the side drain of L2571 and then overland. As this will also be the pump station site requiring daily access, we propose that the access be formalised and gravelled to comfortably accommodate a 1 tonne (t) vehicle reversing onto the site. This would include piping the side drain on L2571.

7.4.2. Reservoir 3-2

The existing reservoir has a capacity of about 50kl, is situated at an elevation of 412msl and receives water from R3-3 by gravity. Site investigation found the reservoir to be leaking from below the floor. There is a redundant non-operational pumpstation at R3-2. This can be properly demolished when the new reservoir is constructed. The reservoir is not fenced.

7.4.2.1. Capacity Determination

This reservoir will supply water to a Y_{2018} count of 50 households. This equates to a direct storage requirement of 70kl.

7.4.2.2. Proposed Works

The existing structure is undersized and is leaking. It is proposed that the reservoir be replaced with a new 100kl reservoir. At the same time the old reservoir and pumpstation can be demolished.

7.4.3. Reservoir 3-3

The reservoir site consists of two existing reservoirs:

Reservoirs 3-3-1 has a capacity of about 40kl, is situated at an elevation of 605msl and receives water from the rising main. The reservoir is of ferro cement construction and showing signs of ageing.

Reservoir 3-3-2 has a capacity of about 100kl, is situates at an elevation of 605msl and receives water from the rising main. The reservoir is a reinforced concrete construction in good condition. The reservoirs are fenced, but this has fallen into disrepair.

7.4.3.1. Capacity Determination

This reservoir will supply water to a Y_{2018} count of 37 households. This equates to a direct storage requirement of 52kl. It further serves as the through reservoir for R3-2, R3-4, R3-5 and R3-10 thus requiring and additional 338kl storage. Total capacity required 390kl.

7.4.3.2. Proposed Works

It is proposed that the old reservoir be demolished, and a new 300 kl reservoir be built on the same spot. The total storage at the R3-3 site will then be 400kl. The 300kl will primarily serve as the through reservoir. It is proposed that the outlet of the 100kl reservoir be modified to have two outlets, one at floor level to serve the local network and one half way up to contribute to through flow storage. In this arrangement the downstream reservoirs cannot over drain R3-3 and leave the local network without water.

7.4.3.3. Access Tracks

Reservoir R3-3 was accessible by four-wheel drive vehicle (4WD) only, and in wet weather even 4Wd access would be very difficult. We propose making a small allowance to improve accessibility to this reservoir.

7.4.4. Reservoir 3-4

The existing reservoir has a capacity of about 100kl, is situated at an elevation of 450msl and receives water from R3-3 by gravity. The reservoir is of ferro cement construction and showing signs of ageing. Access to this site is by foot only.

7.4.4.1. Capacity Determination

This reservoir will supply water to a Y_{2018} count of 151 households. This equates to a direct storage requirement of 212kl.

7.4.4.2. Proposed Works

It is proposed that a new 225 kl reservoir be built and the old reservoir be demolished. An access path is to be constructed as well.

7.4.5. Reservoir 3-5

The existing reservoir has a capacity of about 50kl, is situated at an elevation of 536msl and receives water from R3-3 by gravity. The reservoir is of ferro cement construction and showing signs of ageing. The site is fenced and this remains secure. No one has worked on this reservoir in years as the bush has grown to right against the reservoir. Access to this site is by offroad path.

7.4.5.1. Capacity Determination

This reservoir will supply water to a Y_{2018} count of 149 households. This equates to a direct storage requirement of 210kl.

7.4.5.2. Proposed Works

It is proposed that a new 225 kl reservoir be built and the old reservoir be demolished. An access path is to be constructed as well.

7.4.6. Reservoir 3-6

The existing reservoir has a capacity of 30kl at an elevation of 375msl. It is of reinforced concrete construction.

7.4.6.1. Capacity Determination

Due to the low elevation of this reservoir it will not be used as a network reservoir. It may possibly be used as a break pressure tank, but final analysis of the surrounding networks will dictate the need.

7.4.6.2. Proposed Works

None

7.4.7. Reservoir 3-8

The existing reservoir has a capacity of about 250kl, is situated at an elevation of 362msl and receives water from R3-1 by gravity. The reservoir is of ferro cement construction and showing signs of ageing. Access to this site is by overland path. There is no fence.

7.4.7.1. Placement

Where the reservoir is currently located it is too low to serve some of the houses in it’s supply zone. It is proposed to place a new reservoir on another hill at a higher elevation.

7.4.7.2. Capacity Determination

This reservoir will supply water to a Y_{2018} count of 292 households. This equates to a direct storage requirement of 205kl.

7.4.7.3. Proposed Works

It is proposed that a new 225kl reservoir be built and the old reservoir be demolished. An access path is to be constructed as well.

7.4.8. Reservoir 3-9

The existing reservoir has a capacity of about 150kl, is situated at an elevation of 346msl and receives water from R3-1 by gravity. The reservoir is of ferro cement construction and showing signs of ageing. Access to this site is by overland path. There is no fence.

7.4.8.1. Capacity Determination

This reservoir will supply water to a Y_{2018} count of 153 households. This equates to a direct storage requirement of 108kl.

7.4.8.2. Proposed Works

It is proposed that a new 100kl reservoir be built and the old reservoir be demolished. An access path is to be constructed as well.

7.4.9. Reservoir 3-10

The R3-10 site has two reservoirs.

R3-10-1 The existing reservoir has a capacity of about 40kl. The reservoir is of ferro cement construction and showing signs of ageing.

R3-10-2 The existing reservoir has a capacity of 100kl. The reservoir is of reinforced concrete construction and is in good condition.

The 3-10 site is situated at an elevation of 562msl and receives water from R3-3 by gravity. Access to this site is by foot.

7.4.9.1. Capacity Determination

This reservoir will supply water to a Y_{2018} count of 93 households. This equates to a direct storage requirement of 131kl.

7.4.9.2. Proposed Works

The site is practically inaccessible. It is located well above the closest households. For this reason, it is proposed that a new reservoir be constructed much closer to the village at a lower elevation. It is proposed that a new 100 kl reservoir be built closer and work in line with the existing 100kl to provide 200kl storage. The old ferro cement reservoir is be demolished. An access path is to be constructed as well.

7.4.10. New Reservoir Foundations

For new reservoirs the site preparation would be as follows:

Ensure reservoir location is situated completed within natural soil horizons;

Strip and remove surface vegetation including the shallow colluvial horizons;

Remove tree stumps, remaining roots and organic matter;

Scarify the exposed ground profile to a depth of 0.3m and moisten to 2% above optimum moisture content (OMC) and compact to 98% mod AASHTO density to create a uniform well compacted founding area;

Cast reinforced concrete footings within 24 hours of final ground preparation;

Landscape and shape ground after completion to mitigate the erosive effects of storm water runoff.

The allowable bearing capacity of the underlying residual soils and weathered rocks is anticipated to be between 100kPa for residual soils and 250kPa for founding on weathered rock. A site-specific geotechnical investigation would be required for new reservoirs.

Table 7-3 Summary of Founding Conditions

New Reservoir	Trial Hole	Probable Founding Material and Depth	Foundation Recommendations
R3-1	TH39	Weathered rock occurring at >1,0m depth. Caution to be taken with likely boulder layer	Reinforced concrete ring beam with tied in surface bed nominally reinforced
R3-2	TH60	On residual deep clay silts No rock intersected	
R3-3	TH81	On residual deep clay silts No rock intersected	
R3-4	TH36	On approximately 0,6m on weathered gneiss	
R3-5	TH61	At approximately 0,5m on weathered schist	
R3-8	TH14	At approximately 0,5m on weathered schist	
R3-9	Th19	At approximately 0,4m on weathered schist	
R3-10	TH68 (155m away)	On redidual deep clayey sands. No rock intersected	

7.4.11. Reservoir Controls and Level Indicators

All the reservoirs are to be fitted with float valves to close upon the water level reaching the full mark. The use of sliding floats is proposed to keep surging to a minimum. Those reservoirs connected to pumps can have additional controls dictated by the pump control systems.

We recommend that all reservoirs be fitted with a simple mechanical level indicator that would be clearly visible from a distance.

7.4.12. Fencing

Reservoir sites would be surrounded by a 2.1m security fence comprising a 1.8m high 100x100mm Bonnox mesh on CCA treated poles, topped with 3 strands of barbed wire

7.5. In Scheme Bulk Distribution

Supply of water between the reservoirs is accomplished by the bulk distribution network.

R3-1 is the command reservoir for the SSA3 area. From here two pipelines feed other reservoirs.

- A pump line to R3-3, from where the remaining reservoirs are gravity fed (R3-2, R3-4, R3-5 and R3-10)
- A gravity line to R3-8 and R3-9

There is little as-build drawings of the existing lines and operator knowledge of the lines are limited to rough routing and repairs undertaken recently.

7.5.1. Rising Main R3-1 to R3-3 with Pump station P3-1

Indications from UPW supplied construction plans are that this rising main is a 160Ø uPVC type pipeline build around 2005/2006. The line is 2 178m long and rises 195m. It is assumed the pipeline is class 16 pressure rated.

7.5.1.1. Pumps Station Building

This pump station building is of a masonry construction with sheet metal roofing, a double transformer door provides access and a window provides light.

7.5.1.2. Equipment

2 No. pump-sets, one duty and one standby and a hoist was found in the pump station.

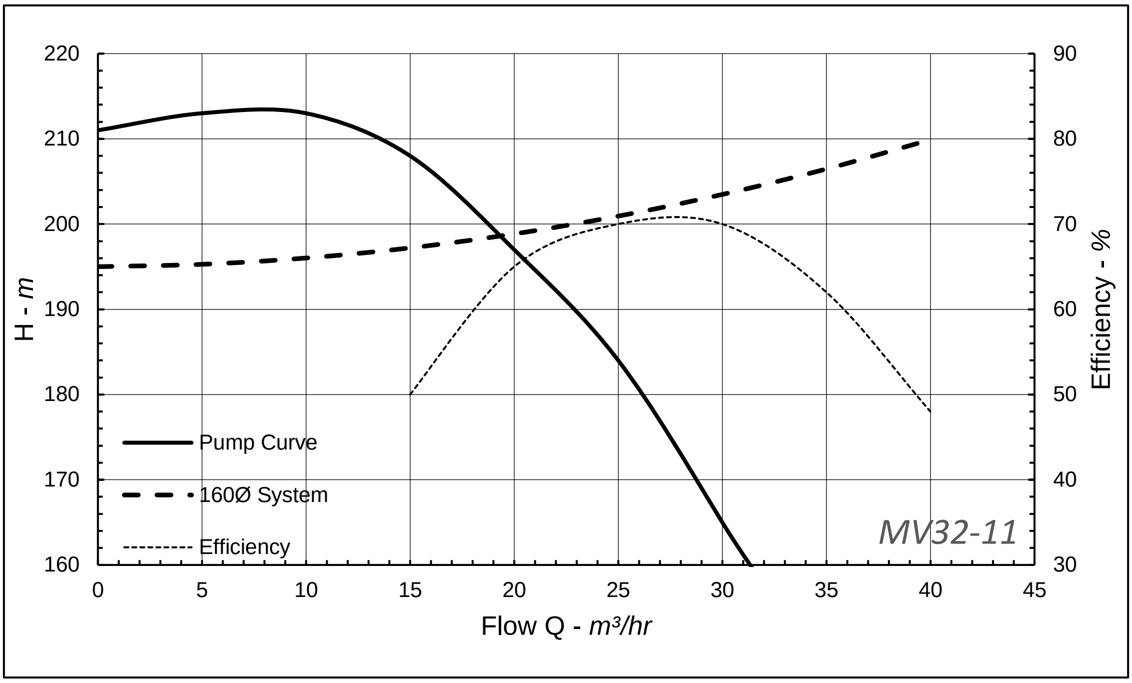
- Pump 1 a USR Industries vertical multi-stage centrifugal pump. The nametag indicates a duty point of 32 m^3/hr (8,9l/s) at 160m head. This pump is of Chinese origin and we were unable to source a local service agent or pump curves
- Pump 2 a CRI-Pumps vertical multi-stage centrifugal pump. The nametag indicates the type as a MV32-11 with the same 32m^3/hr at 160m duty point. Pump curves for this pump was obtained and used further for evaluations.
- Both pumps are driven by Motorelli 3-phase electric motors (22Kw at 50Hz) with Star Delta start-up.
- The building is served by a 100kVA transformer of the Eskom grid.
- The existing Yale hoist has a 0,5t lifting capacity and is mechanically operated by means of a chain. The lifting capacity would be sufficient to lift the pumpset, which weight approximately 250Kg each (pump and motor). We do not envisage a need for upgrading the overhead hoist.

7.5.1.3. Performance

Evaluation of the pump and pipeline curves indicate that the pumps are functioning on the lower end of their efficiency. The graph below indicates the pump curve for the pump found on site overlain with the system curve for the 160Ø pipeline. The two intersect near 19m^3/h@198m indicating a 64% efficiency.

The operators have indicated that the logic control system for the pumps is generally dictated by the level state of R3-1 and not the level state of R3-3. As the Regional Bulk Supply cannot supply enough volume to cater for both the local network coming off R3-1 and the pump line to R3-3, they regularly take an operational action to close the outlet of R3-1 and allow the water level in R3-1 to rise overnight. In the morning they activate the pumps until the low-level switch in R3-1 automatically trips the pumps. The R3-1 outlet is then opened and it again acts as a local network reservoir. R3-3 thus never gets full. There was no set routine noted for the frequency of these pumping operations.

Figure 7-4 Pump Curve for Rising Main Pump



7.5.1.4. The Proposed Works

This pipeline needs to serve the summer peak flow to all the reservoirs served by R3-3. Over an 18-hour pumping day that equates to a capacity of 548_{Y2042}kl/d or 30,4m^3/hr. The present system has a capacity at 19m^3/hr.

The upgrade to the rising main is limited to the pump only, the pipeline at 160Ø is sufficiently sized for this volume. It would only be a 4m increase in head between the current flow of 19 vs. the future demand of 30,4 m^3/hr. A new pump with a duty point of 30,4m^3/hr @203m is to be installed. Energy requirement for this is 16,6kW. At 60% efficiency that would imply a 27kW drive force, likely a 30kW motor. At 70% efficiency that would be a 23kW drive force, which is likely to be a 25kW motor.

7.5.1.5. Operation

The rising main has been sized to pump 18 hours a day. It should be noted that the effect of pumping during the peak electricity tariff period (24-hour pumping) would be to almost double the annual electricity cost (based on current Eskom Ruraflex tariffs). To avoid this, we propose a maximum pumping time of 18 hours based on a pumping cycle of 9 hours on and 3 hours off with the 3 hour off periods coinciding with the Eskom morning and evening peaks. Initially with lower demands, the pumping times will be shorter.

7.5.2. Gravity Bulk Mains

As noted previously there is little data available on the bulk mains. It is not clear if these lines are dedicated bulk lines or mixed bulk and reticulation lines. What is clear is that the interaction between the reservoirs fed from R3-3 will require careful manipulation through the bulk lines. While on site casual enquiries were made from residents in the various areas as to their perception on availability of water in the network.

The comments from the various supply areas were:

- R3-3 : They sporadically have water, if it is there it is soon gone.
- R3-4 : They occasionally have water, they understand that if they have water other villages do not have water and vice versa.
- R3-5 : They nearly always have water.
- R3-10 : For months at a time they do not have water, it may be on briefly but then it is gone again.

Of the reservoirs feeding from R3-3, R3-5 is the second lowest, but fed with the largest pipe – it drains any water in R3-3 quickly, thus starving the other reservoirs. The only time the other reservoirs receive meaningful flow is if successive pump operations managed to fill R3-5. Our crude model of this system corroborated the field experience especially if R3-3 is not kept full.

7.5.2.1. Bulk line R3-3 towards R3-10

From UWP construction plans the pipeline is a 90mm HDPE up to R3-5 branch (2846m), 75mm HDPE thereafter for a total 4855m long.

The capacity requirement for this line is sufficient in terms of volume transfer, it is just the hydraulic head is too low if R3-5 is also open.

7.5.2.2. Branch to R3-5

From UWP construction plans the pipeline is indicated as a 75mm HDPE 470m long.

The capacity requirement of this line is sufficient, the model indicates this reservoir can run full within 6 hours.

7.5.2.3. R3-3 to R3-4

The details of this line is unknown, assumptions are a 50mm HDPE, approximately 2 km's long. There are 2 number of 10kl break pressure tanks installed on the pipeline. It has been reported that these break pressure tanks have been bypassed in order to increase water supply. The system model indicated that this line should be a 75Ø for enough capacity. The 160m height difference can be accommodated without break pressure tanks.

7.5.2.4. R3-3 to R3-2

The details of this line is unknown. It is actually not clear if R3-2 is currently fed from the rising main or from R3-3. The Model shows this line needs to be a 50Ø. This reservoir is hydraulically the most favourable sited from R3-3, if not suitably throttled it will drain R3-3.

7.5.2.5. R3-1 to R3-8

The details of this line is unknown. A 63Ø HDPE line is exposed on what should be the route. The model indicates a 75Ø is required on this line.

7.5.2.6. Branch to R3-9

This line branches off the R3-1 to R3-8 pipeline. The details of this line is unknown. The model indicates a 75Ø is required on this line.

7.5.2.7. Proposed Works

It is proposed that the following bulk mains be upgraded.

Table 7-4 Proposed Internal Bulk Works

Section	Existing	Proposed
R3-3 to R3-10	90Ø and 75ØHDPE	Leave pipes as is, install flow control at the R3-5 Branch T for equitable distribution.
R3-5 Branch	75ØHDPE	
R3-3 to R3-4	Unknown (50Ø assume)	New 75Ø Pipe
R3-3 to R3-2	Unknown	New 50Ø Pipe
R3-1 to R3-8	Unknown (65Ø assume)	New 75Ø Pipe
R3-9 Branch	Unknown	New 75Ø Pipe

It is proposed that flow control be installed at the branch points for all the reservoirs in the form of ratio orifice plates. For example, branch 1 required 30l/s flow and branch 2 required 15l/s then install orifice plates so that the branch 1 orifice is 2 times the area of the branch 2 orifice.

7.6. Reticulation Networks

7.6.1. Existing reticulation networks

The existing networks are scattered over the entire area. They are not well documented, and it is assumed they were installed under the CMIP or similar programme. They were arranged for standpipe connections and it is assumed they were sized for 25l/c/d. The pipework is not deeply buried with several pipes laying exposed on the surface. Several stream crossings, especially dongas, are in poor state. It seems at some time in the past the standpipe level of service was forgo and a yard connection level of service was setup on the existing infrastructure in an improvised manner.

At this point it is assumed that none of the existing reticulation network is of sufficient capacity, or acceptably installed to be part of the higher level of service network and will not be considered for incorporation.

7.6.2. Network Arrangement

The area was separated in network zones that each feed of a single reservoir. The arrangement of the networks considers the hydraulic head of the reservoir over the network, the convenient routing of pipelines along roads and footpaths, the minimizing of environmental impact through avoiding stream crossings where possible, the avoidance of steep topography where possible and the arrangement of clusters of homes.

House connections are typically 25Ø, unless they are long and friction loss needs dictate that they increase.

7.6.3. Proposed network Zone 1

Zone 1 is fed off reservoir R3-1. This network in the centre area of the project. This network is part of phase 2, 3 and 4 and should be completed in 2023, thus 2043 as design horizon. Population of 2208_{Y2043} with a demand need of 331_{Y2043}kl/d. Pipeline sizing varied from 110Ø to 32Ø. With the reservoir being at 416masl and the lowest house in this network being at 250masl 8 break pressure tanks/valves are required to maintain pressures within tolerances.

7.6.4. Proposed network Zone 2

Zone 2 is fed off reservoir R3-2. This network in the centre area of the project. This network should be completed as phase 4 in 2023, thus 2043 as design horizon. Population of 385_{Y2043} with a demand need of 58_{Y2043}kl/d. Pipeline sizing varies from 75Ø to 32Ø. The entire zone is under direct pressure from the reservoir with the highest static pressure being 90m and the lowest dynamic pressure found to be 8m at the household closest to the reservoir.

7.6.5. Proposed network Zone 3

Zone 3 is the smallest of the networks. This network in the highest part of the area will be part of phase 4 and 5 and should be completed in 2024, thus 2044 as design horizon. Population of 288_{Y2044} with a demand need of 43_{Y2044}kl/d. With the reservoir at 612masl and the lowest node at 474masl, 2 break pressure tanks/valves are required in this network to maintain pressures within tolerances

7.6.6. Proposed network Zone 4

Zone 4 is the furthest West of the networks, fed of reservoir R3-4. This network is part of phase 5 and 6 with completion expected in 2025, thus 2045 as design horizon. Population of 1185_{Y2045} with a demand need of 178_{Y2045}kl/d. This network is spread along the river bank for several kilometres with houses above and below road P706 which runs along the river. Pressure problems were encountered along this section. Generally, areas below the road were over pressurised while areas above the road were under pressurised. 7 sub pressure zones were created to get pressures within tolerances. In order to achieve this, significant lengths of dual pipework were required, a high-pressure and a low-pressure pipe in one trench. The low pressure for the immediate vicinity and the high pressure for the areas further along that are too high to be served by the low-pressure zone. The reservoir is at 464masl, the lowest house is at 238masl.

7.6.7. Proposed network Zone 5

Zone 5 is in the Northern side of the project and is fed of reservoir R3-5. This network is planned as part of phase 6 and 7 with completion in 2026, thus 2046 as design horizon. Population of 1181_{Y2046} with a demand need of 177_{Y2046}kl/d. 4 Break pressure tanks are required to regulate pressure between the reservoir at 535masl and the lowest house at 346masl. The topography and network layout forces 3 of these tanks to be 5m elevated tanks to serve the houses further downstream that are nearly at the same elevation as the tank location.

7.6.8. Proposed network Zone 8

Zone 8 is the largest of the networks. It is to the East of the project area. This network is expected to be part of phase 7,8 and 9 with completion in 2028, thus 2048 as design horizon. Population of 2361_{Y2048} with a demand need of 354_{Y2048}kl/d. The analysis of this network was initially problematic with regular pressure breaks with long dual pipelines required and several houses experiencing low pressures. It became clear that the placement of the existing reservoir R3-8 is not suitable for the network. The location was moved to a higher hill and the problems were mostly negated. 6 Break pressure tanks are still required, with 2 of them being elevated by 5m.

7.6.9. Proposed network Zone 9

Zone 9 is to the South of the project area. This network is expected to be part of phase 9 and 10 with completion in 2029, thus 2049 as design horizon. Population of 1250_{Y2049} with a demand need of 187_{Y2049}kl/d. The network also serves the community that reside on the river bank above and below road P706, adjacent to Zone 4. It has the same pressure zoning problems as Zone 4 and was solved in a similar manner with low pressure zones and dual pipelines.

7.6.10. Proposed network Zone 10

Zone 10 is in the far northern area of the project, the most remote and in the steepest area. The network is fed of reservoir R3-10. This network is planned as part of phase 10 and 11 with completion in 2030, thus 2050 as design horizon. Population of 767_{Y2050} with a demand need of 115_{Y2050}kl/d. 6 break pressure tanks/valves will be required to regulate pressure between the reservoir at 561masl and the lowest house at 301masl.

7.6.11. Reticulation Summary

The table below summarises the pipe lengths and features per zone. Overall the reticulation will use 174km of pipework.

Table 7-5 Reticulation Summary

Zone		1	2	3	4	5	8	9	10
Overall pipe lengths		36 794	6 622	4 868	25 887	18 240	44 395	24 273	13 123
Pipe size - class	160-12	1 148					3 665		
	110-12				3 249	504	7 206	4 110	
	110-16				797				
	90-12	1 838	463				1 061	60	
	75-12	5 153		145	2 390	2 078	4 019	2 648	1 298
	75-16				1 890				
	50-12	9 181	2 718	1 772	7 075	6 016	3 696	4 277	922
	50-16				605				
	40-12	3 168			646	1 166	4 011	3 655	427
	32-12	5 959	1 410	1 422	3 684	2 871	10 219	3 346	3 310
	25-12	10 345	2 029	1 527	5 579	5 604	10 516	6 177	7 165
Single Meter		203	37	33	115	118	206	106	60
Double Meter		41	5	1	16	16	40	22	14
Break Pressure		8	1	2	7	4	5	6	6
Elevated tanks						3	2		

7.7. Supplementary Issues to the Water Supply Scheme

7.7.1. Yard Connections

All residents would receive new yard taps with new smart meters installed. The smart meters will conform to KCDM's meter specification.

7.7.2. Bulk Water meters

Bulk meters would be installed on the outlets of reservoirs and on major branches. Provisionally, the total number of meters that would be installed within the system is 8. Water meters would be position inside brickwork meter chambers provided with a drainage sump and a reinforced concrete cover slab. The manhole cover would be a Type 9 grey iron cover and frame. Once again, we propose compression mould polymer cover as an alternative.

7.7.3. Erosion Protection

The steep, hilly and in places mountainous terrain which characterizes the uThukela River Valley along with the geology of steeply dipping and closely jointed metamorphic rocks and high rainfall makes the project area potentially a high-risk site in terms of slope stability. Evidence of previous slope slips/failures was noted along road cuttings, pipelines and bridges. Consequently, provision would be made for extensive erosion protection measures.

Mitigation measures to be considered during design:

New pipe alignments to skirt steep slopes where possible;

Local slope stability measures such as gabions and rock bolsters to be provided;

Minimise the removal of vegetation and reinstate ground cover after completion of work.

7.7.4. Stream and River Crossings

Large, deeply incised erosion gullies were noted along most of the streamlines within the site boundary. The deep residual soils that occur along the various streamline depressions appear to be highly erosive and, in some places, slightly dispersive.

Special attention would be required to ensure that where larger diameter pipelines cross existing gullies as well as areas where future erosion could occur, the pipes were supported, reinforced or sleeved and adequately anchored by gabions or supports resting on underlying rock.

Where pipelines traversed steep gradients into valley lines energy dissipating structures would be provided to reduce the velocity and erosive power of rainfall.

Gabion and/or reno mattresses positioned slightly above the riverbed level would reduce the velocity and erosive power of the water and protect smaller diameter pipelines crossing streams and rivers.

Where pipelines cross streams near existing road bridges or culverts, these would be used to support the pipe. This is done by using steel pipe attached to the side of the bridge.

7.7.5. Power Source and Supply

Eskom was consulted in 2013 to determine the power supply characteristics for the area, specifically with a view to expand the pumpstation load.

Eskom was informed that on a conservative estimate we intended to supply 2 No. new 50kW pumps to replace the existing 2 No. 22kW ones, resulting in an estimated additional 66kVA being required on the network. We intend pumping a maximum of 18 hours a day on this project so that there would be no planned pumping during the peak power demand times. However, it was possible that emergency pumping would be done during peak times so the additional capacity had to be available during the peak periods.

Eskom was supplied with:

- A locality sketch with site co-ordinates;
- Photographs showing overhead power lines on the site as well as the nearby T7154L1 link and Tx number ENX150.

Eskom responded and confirmed.

- The network supplying Middledrift SSA3 was Sitilo NB01;
- This was a 22kV network and not constrained.

Eskom consequently advised us that there was sufficient bulk electricity available to supply the additional power requirements of this scheme, and that we could lodge our application.

7.7.6. Material Type

The use of Polyvinyl Chloride (PVC) either unplasticized PVC (uPVC) or modified PVC (mPVC) would be used for pipelines of 75mm diameter or larger. High Density Polyethylene (HDPE) would be used for pipelines smaller than 75mm diameter. Where the pipeline pressure exceeds 20 bars of pressure Klambon light duty steel pipes would be used. Steel pipe would also be used for above ground installations where required.

HDPE was selected for its durability, ease of handling, transportation and installation. Jointing by means of compression fittings is only needed at 50m or 100m intervals. The light weight of uPVC or mPVC pipes makes it suitable for labour intensive construction. Steel pipe was selected due to its ability to withstand higher pressures as well as resistance to environmental effects.

7.7.7. Pipe Trenching and Bedding

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

7.7.8. Road Crossings

Pipes crossing gravel roads would be carried out by open cut trenching with the necessary provisions for traffic controls. Pipes crossing minor surfaced roads would be carried out by open cut trenching with the necessary provisions for traffic controls. A uPVC sleeve class 16 pipe, 1.5 times greater than the water pipe diameter would be used.

8. DESIGN RISKS

The following are issues and assumptions that may have a bearing on the final solution and will be further refined during the design process.

The accuracy of the survey being used as reference for this stage, it is a ortho scanned survey from 2010 with a accuracy of ±2m. Once the Lidar survey is completed all the networks will be re-analysed.

At this stage the class allowance for the entire reticulation network is class 12, unless it was patently obvious that higher pressures will be encountered. Refinement hereof can take place once improved survey is obtained. This can lower the class for significant parts of the network.

The population count by the ISD will affect the eventual demand numbers. Once the updated count is available the demand on the networks will be re-analysed.

Two sections of pipe is proposed for re-use. It is assumed that since the pipes were installed during 2006 to 2008 that they do have sufficient life left to serve their purpose for the design horizon of this project. The KCDM should see this as a manageable risk that can be mitigated though periodic conditional assessment. The sections are:

- The rising main R3-1 to R3-3.
- The bulk line between R3-3 and R3-10

The application of demand horizon as discussed in section 6.1.2.1. Should the WSA choose to apply method B then the design horizon of all the various components will be re-analysed to suit.

9. ENVIRONMENTAL ASPECTS

9.1. General

There are two environmental approvals received for this project.

1. Environmental Approval DC/28/0030/2012, dated 4 Oct 2013 for Phase 1 of SSA3
2. Environmental approval DC/28/0007/2014, dated 9 Jan 2015 for Phase 2 of SSA3

These phases were as envisioned in 2014, the unbundling as now planned will not be impacted by this as the approved works remain the same.

The environmental consultant is currently conducting field action and compiling a BAR for the addition of the regional bulk supply line and the connections for the ±190 new houses developed since the original approvals. It is this approval that will delay the start of implementation of the first works.

9.2. Heritage Assessment

9.2.1. Early Iron Age Sites

The heritage assessment report identified five archaeological sites within Middledrift SSA3. These sites are located along the banks of the uThukela River (3 sites) and Nsuze River (2 sites), and were all identified as Early Iron Age Sites. These sites are protected by provincial heritage legislation and may not be damaged or altered. These sites are however not threatened by this proposed water supply scheme. Nonetheless it should be noted that these sites require a 100m buffer zone around them.

9.2.2. Modern Grave Sites

A further five modern grave sites were also identified during the heritage assessment. These sites were all less than 60 years old and therefore not protected by provincial heritage legislation. These sites do however have “living heritage” value for members of the deceased and should be treated with respect. A development buffer zone of 10m around such graves was proposed in the heritage assessment report.

9.2.3. Risk Prevention Measures

The authors of the heritage report noted that the uThukela Valley is very rich in heritage sites and archaeological artifacts. There was a high probability that construction excavation could unearth further artifacts and/or heritage structures. Consequently, construction activities should follow existing development corridors. No new access roads may be constructed before a second phase heritage impact assessment has been initiated. Should any artefacts be uncovered during construction, work should cease immediately in that area and the local heritage agency contacted.

10. ESTIMATED PROJECT COSTS

A breakdown of the total estimated project cost is provided Appendix E. All costs were base dated to 07/2018. The entire project was unbundled into phases that do not exceed R60million per annum. Escalation was applied at 6,5% per annum.

The estimated base year project cost is R530,93 Million excl VAT.

With the unbundling over 11 years the final project cost comes to R783,24 Million excl VAT.

A summary of the estimated base year costs is shown below.

Table 10-1 Estimated Base Year Costs

Portion	R (Million)
Regional Bulk Supply 200Ø	53.087
Upper Bulk	13.960
Lower Bulk	9.099
Reservoirs	15.219
Zone 1 Retic	91.193
Zone 2 Retic	17.301
Zone 3 Retic	13.375
Zone 4 Retic	64.549
Zone 5 Retic	45.250
Zone 8 Retic	112.012
Zone 9 Retic	60.536
Zone 10 Retic	35.344
Total	**530.925**

This total translates to a per capita cost of R73 000.

10.1. Phasing

As noted previously a rudimentary unbundling of the project was applied. The constraints on the unbundling are the annual budgetary limit of R60million and the 18-month phase duration limit. Table 10-2 indicates how much of each portion of the works can be accomplished in each phase. For now, each phase equates to a year, the last 6 months of the 18-month phase limit is currently reserved for unforeseen events.

Table 10-2 Phasing Breakdown

	% Breakdown										
Phase>	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
RBS 200	95%	5%									
Upper Bulk		100%									
Lower Bulk		100%									
Reservoirs		100%									
Zone 1		10%	55%	35%							
Zone 2				100%							
Zone 3				0%	100%						
Zone 4					55%	45%					
Zone 5						45%	55%				
Zone 8							20%	45%	25%		
Zone 9									35%	65%	
Zone 10										30%	70%

10.2. Cashflow

Table 10-3 Cashflow Projection

Phase	Financial Year[4]	Effective Escalation[1]	Phase Cost		Budget Limit[3]
			Excl. VAT	Incl. VAT	
Planning	2018/2019	0%	26.120	30.038	60.00
1	2019/2020	11.00%	51.168	58.844	66.66
2	2020/2021	17.92%	58.732	67.541	70.75
3	2021/2022	25.29%	65.021	74.775	75.17
4	2022/2023	33.15%	67.033	77.088	79.89
5	2023/2024	41.51%	70.514	81.091	84.91
6	2024/2025	50.41%	76.427	87.891	90.25
7	2025/2026	59.90%	77.931	89.620	95.94
8	2026/2027	70.00%	88.58	101.868	102.00
9	2027/2028	80.76%	91.721	105.479	108.46
10	2028/2029	92.21%	98.507	113.283	115.33
11	2029/2030	104.42%	52.542	60.423	122.65
Total			**824.296**	**947.941**	

[1] The rate applied is 6,5% per annum. The effective escalation contains the escalation prior to the phase starting and escalation during construction. It is calculated with July 2018 as base date until the end of the financial year. (i.e. for the Phase 1 it is 2 years of escalation July 2018 to June 2020)

[2] The base year unbundled cost is the application of the percentages shown in section 10.1 to the base year costs per section of work.

[3] The budget limit is the R60 million per annum limitation provided by KCDM escalated at the same 6.5% rate.

[4] The financial year indicated is the time period during which the expenditure is expected to take place. The escalation is to the end of this period.

11. PROGRAMME

The programme to complete the design phase is attached as Appendix F.

Preliminary Design Report	10 January 2019
Detail Design Report	27 March 2019
Completion of Enviro Approval	4 September 2019
Approval by KCDM	To suit KCDM
Tender Documentation	To suit KCDM
Tender Advertisement:	To suit KCDM
Tender Closure	Plus 4 weeks from advertisement
Tender Adjudication	Plus 6 weeks from advertisement
Appointment of Contractor:	This should aim for just after the Environmental approval is obtained.
Commencement of Works:	Plus 16 weeks from advertisement
Completion of Works:	Plus 52 weeks from commencement
Release of Retention:	Plus 52 weeks from completion

12. CONCLUSION

12.1. Overview

The water supply available to the residents of Middledrift Sub Supply Area 3 is poor.

The largest single stumbling block to this is the regional bulk supply line that cannot presently supply the areas demand. To a lesser extent the rising main from R3-1 to R3-3 cannot pump the required volume to R3-3 and once water does get to R3-3 the bulk system does not equitably distribute the water to the secondary reservoirs.

The reticulation systems installed in the villages are old and to a low level of service. It was poorly installed (we can imagine that lack of funds and the hard geology likely forced the hand of those that installed it previously to place it shallow). It has been expanded on beyond its capacity through improvised extensions and amendments.

All this works together to create a poor level of service to the residents.

12.2. Proposed Solutions

It is proposed that:

- The regional bulk line be replaced with a dedicated 200Ø pipeline. There are options for the KCDM at their discretion to increase this to 250Ø to provide extended design horizon for this section.
- The pump station at R3-1 for the rising main be upgraded to a $30m^3/hr$ system.
- All the Ferro Cement reservoirs be decommissioned / demolished and replaced with new reservoirs to suit the demands.
- The bulk system between the reservoirs be improved by new pipes where required and installing flow control at the branches to regulate equitable sharing.
- The zone networks be upgraded and expanded to allow for a higher level of service.

12.3. Way Forward

12.3.1. Design Horizon

As per section 6.1.2.1 Method A was used in this report, KCDM are to indicate their acceptance thereof or alternately indicate that Method B should be applied.

12.3.2. Regional Bulk Supply Line

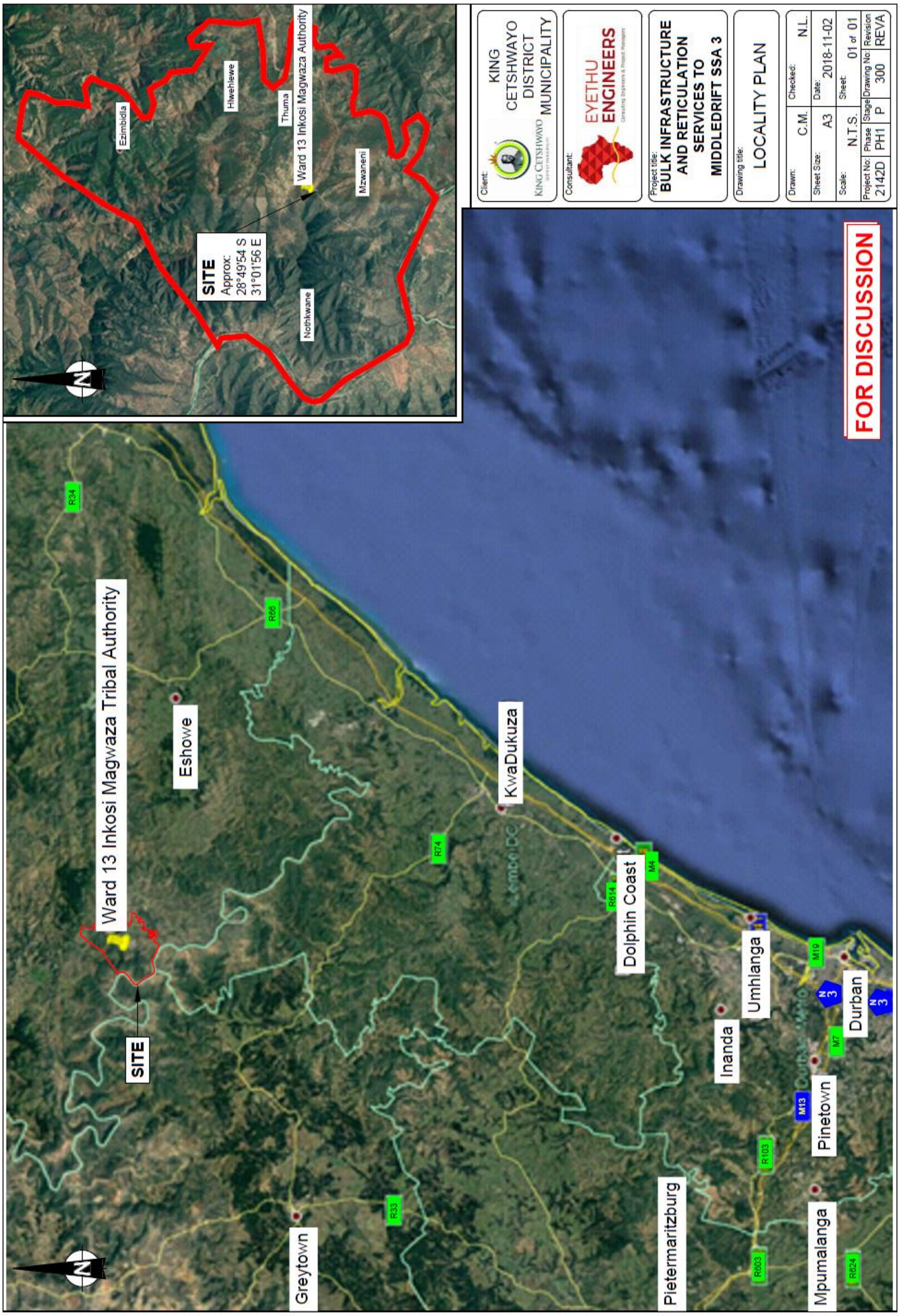
This report contains options that that KCDM as Water Service Authority needs to consider, discuss and select a way forward around the operational strategy of the regional bulk supply line. Once selected it will guide the detail design of this aspect.

12.3.3. Rest of the Proposed System

Should the KCDM agree with the rest of the proposals the details design thereof can start.

This concludes the re-assessment report of the proposed Middledrift Sub Supply Area 3 Bulk and Reticulation Project.

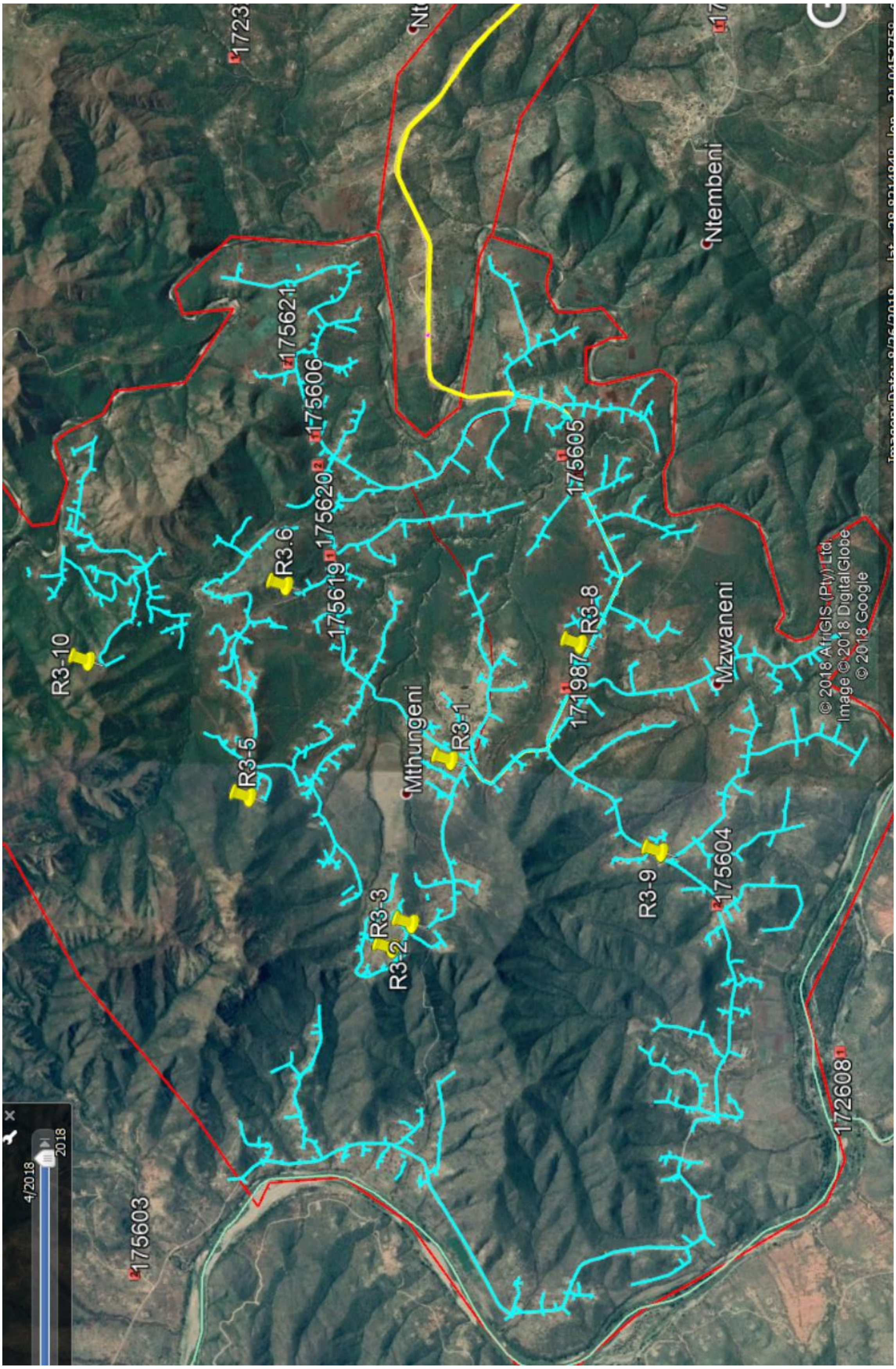
Appendix A Locality Plan



Appendix B Water Use Licence

Appendix C Borehole Data

Location of boreholes extracted from DWAF database



Appendix D Middledrift Water Treatment Works Growth Scenario

ESTIMATED DEMAND on MIDDLEDRIFT WTW

	2018		2019		2020		2021		2022		2023		2024		2025	
SSA	% connected	Demand	% connected	Demand	% connected	Demand	% connected	Demand	% connected	Demand	% connected	Demand	% connected	Demand	% connected	Demand
1	50%	1.09	50%	1.10	50%	1.12	50%	1.13	50%	1.15	50%	1.17	50%	1.19	50%	1.20
2	30%	0.82	30%	0.83	40%	1.12	50%	1.42	60%	1.72	70%	2.02	80%	2.34	90%	2.65
3	30%	0.33	30%	0.33	30%	0.34	50%	0.57	65%	0.75	75%	0.87	85%	1.00	95%	1.13
4	50%	0.61	50%	0.62	50%	0.63	50%	0.64	50%	0.65	50%	0.66	50%	0.67	50%	0.68
5	25%	0.60	35%	0.85	55%	1.35	75%	1.87	95%	2.40	100%	2.57	100%	2.60	100%	2.64
6	30%	1.32	30%	1.34	30%	1.36	30%	1.38	30%	1.40	30%	1.42	30%	1.44	30%	1.46
7	30%	0.63	30%	0.64	30%	0.65	30%	0.66	30%	0.67	30%	0.68	30%	0.69	30%	0.70
8	30%	0.67	30%	0.68	30%	0.69	30%	0.70	30%	0.72	30%	0.73	30%	0.74	30%	0.75
Total		**6.07**		**6.40**		**7.26**		**8.37**		**9.45**		**10.11**		**10.66**		**11.22**

This table is INDICATIVE of when the treatment works may run out of capacity.

Assumptions:

Growth in SSA3 as per this reports phasing.

Other known areas of expansion is in SSA2 and 5 (Aecom, Sivest, and Izingalabezi)

Remainder of area left at current service rates

Appendix E Cost Estimate

REGIONAL BULK SUPPLY LINE – 200Ø 15KM

DESCRIPTION			AMOUNT (RAND)
SECTION 1 : SITE CLEARANCE			1 420 000.00
SECTION 2 : EARTHWORKS PIPE TRENCHES			11 780 000.00
SECTION 4 : GABIONS AND PITCHING			150 000.00
SECTION 5 : PIPE BEDDING			2 130 000.00
SECTION 6 : PIPE JACKING			1 370 000.00
SECTION 6 : MEDIUM PRESSURE PIPELINES			16 050 000.00
SECTION 7 : REHABILITATION			530 000.00
Total Of Sections			33 430 000.00
Compliance obligations		7.50%	2 507 250.00
Sub Total			35 937 250.00
P&G		15%	5 390 587.50
Sub Total			41 327 837.50
Contingency		10%	4 132 783.75
Construction Works total >			45 460 621.25
Prof Fees			
Up to stage 4	6%	45 460 621.00	2 727 637.26
At completion	6%	45 460 621.00	2 727 637.26
Sub Total			5 455 274.52
Survey			386 100.00
Enviro			176 000.00
ISD	2%	45 460 621.00	909 212.42
Disbursements			300 000.00
Site Sup			400 000.00
Indirect Costs Total			7 626 586.94
To Phase Split			53 087 208.19

UPPER BULK PIPELINES

DESCRIPTION			AMOUNT (RAND)
SECTION 1 : SITE CLEARANCE			1 021 154.85
SECTION 2 : EARTHWORKS PIPE TRENCHES			4 267 615.35
SECTION 4 : GABIONS AND PITCHING			214 855.30
SECTION 5 : PIPE BEDDING			650 053.40
SECTION 6 : MEDIUM PRESSURE PIPELINES			3 107 418.75
SECTION 7 : REHABILITATION			298 595.10
			9 559 692.75
Compliance obligations		7.5%	716 976.96
Sub Total			10 276 669.71
P&G		15%	1 541 500.46
Sub Total			11 818 170.17
Contingency		10%	1 181 817.02
Construction Works total			12 999 987.19
Prof Fees			
Up to stage 4	6%	12 999 987	779 999.22
At completion	6%	12 999 987	779 999.22
Sub Total			1 559 998.44
ISD	2%	12 999 987	259 999.74
Disbursements			300 000.00
Site Sup			400 000.00
Sub Total			2 519 998.18
To Phase Split			13 959 986.93

LOWER BULK PIPELINES

DESCRIPTION			AMOUNT (RAND)
SECTION 1 : SITE CLEARANCE			569 933.08
SECTION 2 : EARTHWORKS PIPE TRENCHES			2 834 759.31
SECTION 4 : GABIONS AND PITCHING			155 049.81
SECTION 5 : PIPE BEDDING			441 153.85
SECTION 6 : MEDIUM PRESSURE PIPELINES			1 894 292.51
SECTION 7 : REHABILITATION			159 896.92
Total Scheduled Items			6 055 085.48
Compliance obligations		7.5%	454 131.41
Sub Total			6 509 216.89
P&G		15%	976 382.53
Sub Total			7 485 599.42
Contingency		10%	748 559.94
Construction Works total			8 234 159.36
Prof Fees			
Up to stage 4	6%	8234159.36	494 049.56
At completion	6%	8234159.36	494 049.56
Sub Total			988 099.12
ISD	2%	8234159.36	164 683.19
Disbursements			300 000.00
Site Sup			400 000.00
To Phase Split			9 098 842.55

RESERVOIRS

DESCRIPTION			AMOUNT (RAND)
SECTION 1: STRUCTURAL WORKS			7 787 500.00
SECTION 2: MECHANICAL ELECTRICAL			240 000.00
SECTION 3: ROAD WORKS			2 440 000.00
Total Scheduled Items			10 467 500.00
Compliance obligations		7.50%	785 062.50
Sub Total			11 252 562.50
P&G		15%	1 687 884.38
Sub Total			12 940 446.88
Contingency		10%	1 294 044.69
Construction Works total >			14 234 491.57
Prof Fees			
Up to stage 4	6%	14 234 492	854 069.52
At completion	6%	14 234 492	854 069.52
Sub Total			1 708 139.04
ISD	2%	14 234 492	284 689.84
Disbursements			300 000.00
Site Sup			400 000.00
Total Indirect Costs			2 692 828.88
To Phase Split			15 219 181.41

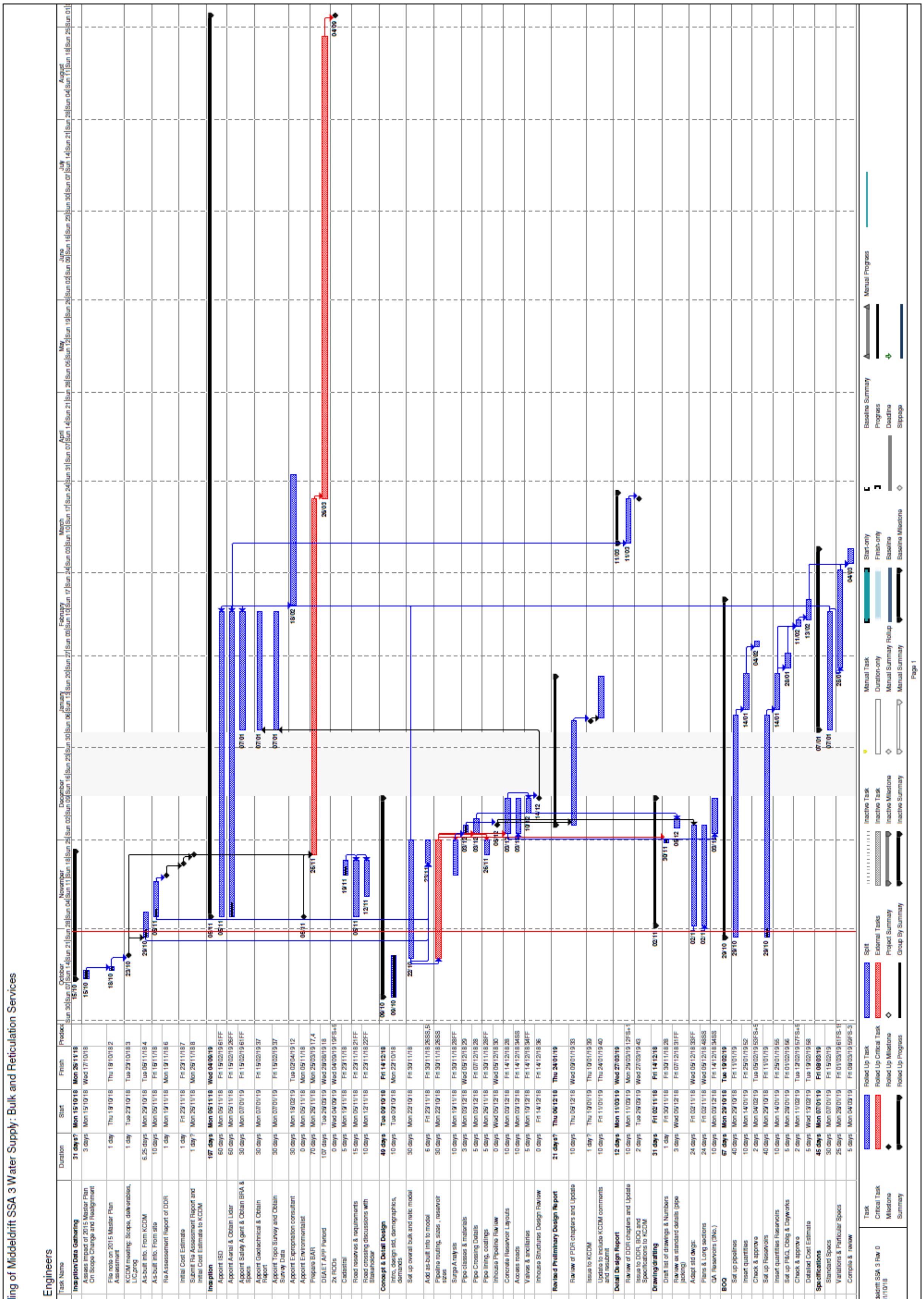
ZONES 1 TO 4

DESCRIPTION		ZONE 1 AMOUNT	ZONE 2 AMOUNT	ZONE 3 AMOUNT	ZONE 4 AMOUNT
SECTION 1 : SITE CLEARANCE		1 244 767.09	224 887.51	167 488.81	879 801.00
SECTION 2 : EARTHWORKS PIPE TRENCHES		18 588 267.95	3 453 731.40	2 599 097.67	12 844 608.08
SECTION 4 : GABIONS AND PITCHING		347 288.28	347 288.28	347 288.28	347 288.28
SECTION 5 : PIPE BEDDING		37 769 178.41	6 801 742.66	5 000 128.04	26 589 645.16
SECTION 6 : MEDIUM PRESSURE PIPELINES		6 280 838.17	950 447.37	881 836.27	4 656 631.54
SECTION 7 : REHABILITATION		1 009 963.98	189 964.63	142 299.06	713 537.59
Total Scheduled Items		65 240 303.88	11 968 061.85	9 138 138.13	46 031 511.65
Compliance obligations	7.5%	4 893 022.79	897 604.64	685 360.36	3 452 363.37
Sub Total		70 133 326.67	12 865 666.49	9 823 498.49	49 483 875.02
P&G	15%	10 519 999.00	1 929 849.97	1 473 524.77	7 422 581.25
Sub Total		80 653 325.67	14 795 516.46	11 297 023.26	56 906 456.27
Contingency	10%	8 065 332.57	1 479 551.65	1 129 702.33	5 690 645.63
Construction Works total >		88 718 658.24	16 275 068.11	12 426 725.59	62 597 101.90
Prof Fees					
Up to stage 4	6%	5 323 119.49	976 504.09	745 603.54	3 755 826.11
At completion	6%	5 323 119.49	976 504.09	745 603.54	3 755 826.11
Sub Total		10 646 238.98	1 953 008.18	1 491 207.08	7 511 652.22
ISD	2%	1 774 373.16	325 501.36	248 534.51	1 251 942.04
Disbursements		300 000.00	300 000.00	300 000.00	300 000.00
Site Sup		400 000.00	400 000.00	400 000.00	400 000.00
Total Indirect Costs		13 120 612.14	2 978 509.54	2 439 741.59	9 463 594.26
To Phase Split		91 193 031.40	17 300 569.47	13 375 260.10	64 549 043.94

ZONED 5 TO 10

DESCRIPTION		ZONE 5 AMOUNT	ZONE 8 AMOUNT	ZONE 9 AMOUNT	ZONE 10 AMOUNT
SECTION 1 : SITE CLEARANCE		621 367.60	1 493 340.95	826 960.32	445 781.92
SECTION 2 : EARTHWORKS PIPE TRENCHES		9 135 686.35	23 251 417.98	12 052 000.90	7 325 547.74
SECTION 4 : GABIONS AND PITCHING		231 525.52	347 288.28	347 288.28	347 288.28
SECTION 5 : PIPE BEDDING		18 735 077.02	45 599 986.99	24 931 828.22	14 352 731.23
SECTION 6 : MEDIUM PRESSURE PIPELINES		2 888 359.01	8 340 812.44	4 310 932.09	2 138 234.37
SECTION 7 : REHABILITATION		505 719.13	1 216 540.02	669 675.72	366 651.20
Total Scheduled Items		32 117 734.63	80 249 386.66	43 138 685.53	24 976 234.74
Compliance obligations	7.5%	2 408 830.10	6 018 704.00	3 235 401.41	1 873 217.61
Sub Total		34 526 564.73	86 268 090.66	46 374 086.94	26 849 452.35
P&G	15%	5 178 984.71	12 940 213.60	6 956 113.04	4 027 417.85
Sub Total		39 705 549.44	99 208 304.26	53 330 199.98	30 876 870.20
Contingency	10%	3 970 554.94	9 920 830.43	5 333 020.00	3 087 687.02
Construction Works total >		43 676 104.38	109 129 134.69	58 663 219.98	33 964 557.22
Prof Fees					
Up to stage 4	6%	2 620 566.26	6 547 748.08	3 519 793.20	2 037 873.43
At completion	6%	2 620 566.26	6 547 748.08	3 519 793.20	2 037 873.43
Sub Total		5 241 132.52	13 095 496.16	7 039 586.40	4 075 746.86
ISD	2%	873 522.09	2 182 582.69	1 173 264.40	679 291.14
Disbursements		300 000.00	300 000.00	300 000.00	300 000.00
Site Sup		400 000.00	400 000.00	400 000.00	400 000.00
Total Indirect Costs		6 814 654.61	15 978 078.85	8 912 850.80	5 455 038.00
To Phase Split		45 249 626.47	112 011 717.38	60 536 484.38	35 343 848.36

Appendix F Programme

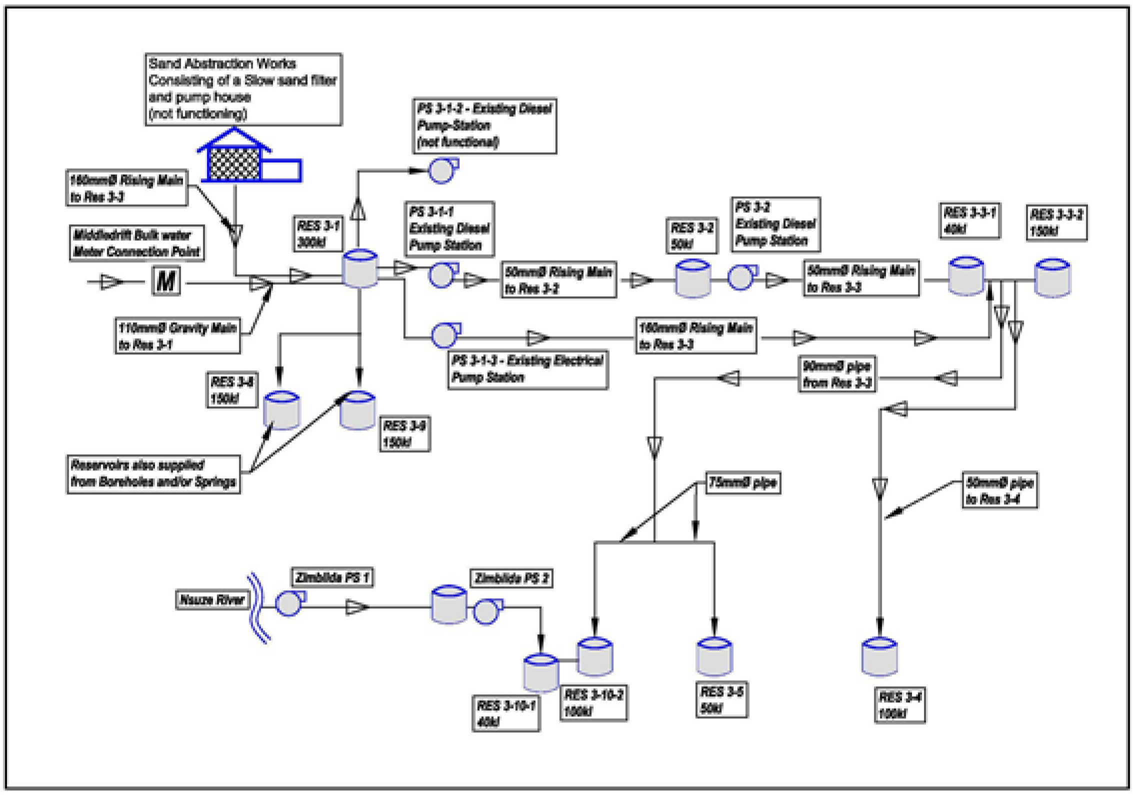


Appendix G As Build Data

Background

The Appendix is a collection of all the as build data and knowledge of the existing works that have been collected during the course of the design phase.

The Figure below shows the original scheme layout for the Middledrift SSA 3 from around 2010, several of these parts have since fell into disuse.



Water reticulation infrastructure covers approximately 85% of the project area, consisting of various schemes supplied from various sources and distribution reservoirs. Installation dates are unknown, however it is estimated that approximately 80% of the existing infrastructure could have been installed prior to the year 1996. There are currently no designated hydraulic supply zones within the scheme/s with off-takes to households present on all of the supply lines to reservoirs. A large portion of residents do not receive a continuous 24-hour water supply, with some not receiving water at all.

Parts of area are still sourcing untreated water from springs, boreholes and rivers.

Water was being supplied to consumers via a reticulation network, consisting of pipelines with varying diameters and materials, and communal standpipes situated throughout the village footprint. Due to various problems arising from the supply from standpipes, such as numerous 'illegal' connections, stagnant water due to insufficient drainage which exposes consumers to possible health risks, excessive wastage etc, a decision was made to provide each household with yard connections. These yard connections were installed without an approved design review and were an 'extension' of the existing schemes. As these existing schemes were not originally designed for yard connections, the increased hydraulic demands would result in increased wear and tear, with pipelines having insufficient capacities. Furthermore, various upgrades and 'emergency on site' installations were carried out to augment or bypass non-operational infrastructure, such as bypassing break pressure tanks in an effort to increase supply. As a result, the existing pipelines in these areas have been exposed to high pressures over the past years. The conditions of these pipelines are therefore expected to be fairly poor and are therefore more likely prone to bursts.

Field investigations also showed severely deteriorated pipelines due to weather exposure as a result of erosion over the years.

Existing reservoirs constructed from Ferro – cement, were functional, however these reservoirs are old, and showed signs of previously been repaired and patched, and would require regular and increasing maintenance in future. Existing reservoirs with sufficient capacity not constructed from ferro-cement would be reused. They would require repairs to ensure future functionality and operations. In accordance with hydraulic designs, reservoirs that do not have sufficient capacity would be replaced with new reinforced concrete structures. We therefore recommend that these reservoirs, constructed from Ferro cement be demolished and replaced.

There is a lack of knowledge regarding the pipe types, diameters and classes of the existing system/s of the project area. As-built drawings received contain information for only 20% of pipelines; the remaining 80% provide no details. To obtain this information to the level of detail that would be needed to complete the design in order to upgrade this reticulation, would require an extensive on-site investigation whereby trial holes would need to be excavated throughout the scheme. This exercise would be time consuming and costly.

Available As-Built Information

This section describes and discusses the review of as-built drawings only, to establish details and validity of the existing infrastructure within the project area.

To source as-built drawings was initially a challenging task, as the original designers were unknown. During a site visit, we were handed a roll of construction drawings from a KCDM operator. These drawings covered UDM/MIG/07/2005 completed in November 2008 and partially situated within the area now known as SSA 3 as listed below:-

Drawing No.	Sheet	Rev.	Size	Drawing Title
21388/2/001	1 of 1	1	A0 and A1	General Layout and Locality Plan
21388/2/101	1 of 1	1	A0	Reticulation Layout Plan
21388/2/102	1 of 1	1	A1	Node Point Details
21388/2/201	1 of 2	1	A0 and A1	Rising main Layout Plan and Longitudinal Section
21388/2/202	2 of 2	1	A0	Rising main Layout Plan and Longitudinal Section
21388/2/301	1 of 3	1	A0 and A1	Gravity Main Layout Plan and Longitudinal Section
21388/2/302	2 of 3	1	A0	Gravity Main Layout Plan and Longitudinal Section
21388/2/303	3 of 3	1	A0 and A1	Gravity Main Layout Plan and Longitudinal Section
21388/2/401	1 of 3	1	A1	150kl Reservoir General Arrangement
21388/2/402	2 of 3	1	A1	150kl Reservoir inlet and outlet chamber details
21388/2/403	3 of 3	1	A1	150kl Reservoir access Ladder, Level indicator, Scour a
21388/2/501	1 of 3	1	A1	100kl Reservoir General Arrangement
21388/2/503	3 of 3	1	A1	100kl Reservoir access Ladder, Level indicator, Scour a
21388/2/801	1 of 2	1	A1	Standard Details

The total length of pipeline shown on the drawings, was calculated to be approximately 108km's long.

Approximately 80% of the existing infrastructure does not contain any details or information regarding pipeline sizes, classes and lengths. It is estimated, judging by the visual observations conducted during site visits, that those schemes could have been installed earlier than 1996, approximately 20 years ago.

Information and details were only provided for approximately 20% of the existing infrastructure, constructed during 2008, and consist of the following;

- The installation of a new electrically operated pump station;
- The construction of 2 reservoirs, Res 3-3-2 (150kl) and Res 3-10-2 (100kl);

A total pipeline length of approximately 20km's, for bulk and reticulation infrastructure consisting of the following:-

- The installation of a 160mm diameter rising main from Res 3-1 to Res 3-3, approximately 2km's long;
- The installation of a 50mm diameter gravity pipeline from Res 3-3 to Res 3-4, approximately 2 km's long, as well as 3 x 10kl break pressure tanks;
- The installation of gravity mains from Res 3-3 to Res 3-5 and Res 3-10 via 90mm and 75mm diameter pipelines;
- Reticulation pipelines from Res 3-10-2 to a small portion of residents within the eZimblida and Hlwehlewe areas, approximately 9.2 km's in length.

Pump Stations

There are 3 pump stations located at the Res 3-1 site. Two (2) older diesel pump stations (PS 3-1-1 & PS 3-1-2) and an electrically operated pump station (PS 3-1-3). PS 3-1-2 initially pumped water from Res 3-1 via a 50mm diameter rising main, approximately to Res 3-2. Pump station 3 (PS 3-1-3) was not operational at the time of various site visits in 2013. Neither the WSSA manager nor the local the site operator know much about it. It is assumed that PS 3-1-3 initially pumped water to an existing reservoir (Res 3-6) located north of Res 3-1. Pump station 3 (PS 3-1-3) pumps water via a 160mm rising main approximately 2.4km long to Res 3-3 at an elevation of approximately 612m. This pump station was installed approximately during the year 2008 prior to the construction of the diesel pumps.

<u>Pump Station Building No. 3 (PS 3-1-1)</u>

The pump station building was situated in a concrete block-work building with regular ventilation openings and contained a Lister diesel motor and pump which pumped via a ND50mm rising main to the 50Kl R3-2 (412m). The pump needs to pump water over a small hill before ground levels drop again towards R3-2.

The diesel pump typically operates for up to 9 hours a day from about 07h00 to 16h00, but on some days it is not used at all. There was no float control on reservoir R3-2 and the operator reported that the demand in Zone 3-2 was small resulting in this reservoir not having to be filled to capacity every day.

<u>Pump Station Building No. 2 (PS 3-1-2)</u>

The pumps are positioned in a small structure with wire mesh sides and corrugated iron roof. The pump station was not operational at the time of various site visits in 2013. Neither the WSSA manager nor the local the site operator know much about it. We assume that this pump could be a backup or booster to the Lister Pump in Building No. 3, or is redundant.

<u>Pump Station Building No. 1 (PS 3-1-3)</u>

This pump station building is electrically operated and comprises of a red brick construction pump house building housing 2 No. pump-sets, one duty and one standby and a 0.5t Yale mechanically operated (chain) hoist as shown in photographs in Appendix D. Each pump-set comprised the following;

- Motorelli vertical 3-phase electric motors (22Kw at 50Hz) with Star Delta start-up provided;
- USR Industries vertical multi-stage centrifugal pumps. Each pump had a stated duty point of 32 m3/hr (8,9l/s) at 160m head. These pumps are of Chinese origin and we were unable to source a local service agent or pump curves

These two pumps supply the 40Kl reservoir R3-3-1 and 90Kl reservoir R3-3-2 (612m) directly via a ND160mm rising main. The static pumped head is 196,4m. According to the operator, these pumps switch on automatically by float control, and only pump for about 6 hours a day since there is insufficient water in reservoir R3-1 to operate the pumps for longer periods of time. Furthermore, these pumps are inadequately sized to meet design requirements as the minimum required pump duty head is approximately 200m. Therefore this pump is functioning inefficiently and would be replaced with new suitably designed pumps.

<u>Pump Station PS 3-2</u>

This pump station had a 2500cm^3 Hatz diesel powered pump, which pumps up to R3-3-1 & R3-3-2 via an ND50mm pipe. This pump station completed the diesel powered alternative pumped line to reservoirs R3-3 giving the system some redundancy.

Zimbidla Pump Station 1& 2

This pump station was still operational in 2013 and was typically pumping for about 7 hours a day. It could continue to be used as a backup supply to the area and eventually be made redundant and replaced by water supply from reservoirs R3-6 and R3-10.

RESERVOIRS

Reservoir	Approx. Capacity [Kl]	Functionality	Material	Condition
R3-1	300	Operational	Ferro-Cement	Visible cracks between roof and wall, no visible leaks.
R3-2	50	Operational	Ferro-Cement	Very good.
R3-3-1	40	Operational	Ferro-Cement	Good. Some minor cracks.
R3-3-2	100	Operational	Reinforced Concrete	Very good.
R3-4	100	Operational	Ferro-Cement	Fair to Good.
R3-5	50	Operational	Reinforced Concrete	Very good.
R3-6	30	Operational	Ferro-Cement	Very good.
R3-8	150	Operational	Ferro-Cement	Fair. Sagging roof, visible cracks between roof and wall, no visible leaks. Serves large population.
R3-9	150	Operational	Ferro-Cement	Fair. Sagging roof, visible cracks between roof and wall, no visible leaks. Appears to be Ferro-cement concrete construction.
R3-10-1	100	Disconnected to pipeline	Reinforced Concrete	Very good.
R3-10-2	40	Operational, but rarely used	Reinforced Concrete	Very good.
ADR0	50	Operational	Steel	Very good
ADR 1	30	Not Operational		Walls are in good condition, roof collapsed, vertical cracks from wall base, and signs of leaking on wall vertical joints.
ADR 2	30	Not Operational		Roof collapsed, walls are in good condition (minor cracks at vertical joints).
ADR 3	30	Not in use		Walls are in good condition, big cracks on roof and can collapse anytime.