water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

uMKHOMAZI WATER PROJECT PHASE 1

Construction of the Smithfield Dam and its associated infrastructure

PRE-CONSTRUCTION ENVIRONMENTAL MANAGEMENT PROGRAMME

January 2022

[DFFE Ref. No.: 14/12/16/3/3/3/94]

TITLE AND APPROVAL PAGE

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Department of Water and Sanitation

NEMAI CONSULTING

AMENDMENTS PAGE

Date	Nature of Amendment	Amendment No.	Signature
December 2021	Draft for Authorities and Public Review	0	
February 2022	Final for Submission to DFFE for Decision-Making	1	

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LIST OF ACRONYMS & ABBREVIATIONS

DFFE	Department of Forestry, Fisheries and Environment
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EKZNW	Ezemvelo KZN Wildlife
EMC	Environmental Monitoring Committee
EMPr	Environmental Management Programme
I&AP	Interested and Affected Party
KZN	KwaZulu-Natal
NEMA	National Environmental Management Act (Act No. 107 of 1998)
OHS	Occupational Health and Safety
RAP	Relocation Action Plan
SCC	Species of Conservation Concern
TBM	Tunnel Boring Machine
uMWP-1	uMkhomazi Water Project Phase 1
WSS	Water Supply System
WTW	Water Treatment Works

DEFINITION OF KEY TERMS

Auditing	*A systematic and objective assessment of an organisation's activities and services conducted and documented on a periodic basis.*
Competent	*Combination of knowledge, qualifications and experience specific to the work or task being performed.*
Construction Area	*Immediate site influenced by specific construction activities, as approved by the Engineer.*
Construction Domain	*Entire footprint required for the construction of the overall project components.*
Environment	*The surroundings in which humans exist and which comprise:* • *The land, water and atmosphere of the earth.* • *Micro-organisms, plant and animal life.* • *Any part or combination of a) and b) and the interrelationships among and between them.* • *The physical, chemical, aesthetic and cultural properties and conditions of the foregoing that can influence human health and well-being.*
Environmental Aspect	*Those components of the company's activities, products and services that are likely to interact with the environment.*
Environmental Feature	*Elements and attributes of the biophysical, economic and social environment.*
Environmental Impact	*The change to the environment resulting from an environmental aspect, whether desirable or undesirable. An impact may be the direct or indirect consequence of an activity.*
Environmental Management Programme (EMPr)	*A detailed plan of action prepared to ensure that recommendations for enhancing positive impacts and/or limiting or preventing negative environmental impacts are implemented during the life-cycle of a project.*
Environmental Objective	*Overall environmental goal pertaining to the management of environmental features.*
Environmental Target	*Performance requirement that arises from the environmental objectives and that needs to be set and met in order to achieve those objectives.*
Monitoring	*A systematic and objective observation of an organisation's activities and services conducted and reported on regularly.*
Potable Water	*Water that is fit or suitable for drinking.*
Project Area	*The greater area within which the project is executed. Extends beyond the construction domain.*
Raw Water	*Natural (untreated) water found in the environment, such as water from bodies like dams and rivers.*
Sensitive environmental features	*Environmental features protected by legislation (e.g. heritage resources), or identified during the EIA as sensitive through specialists' findings and input received from Interested and Affected Parties.*

Watercourse	*A geomorphological feature characterized by the presence of a streamflow channel, a floodplain and a transitional upland fringe seasonally or permanently conveying surface water. According to the National Water Act (Act 36 of 1998), a watercourse constitutes a river or spring, a natural channel in which water flows regularly or intermittently, a wetland, lake or dam into which, or from which, water flows, and any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.*
Weeds and Invader Plants	*Weeds and invader plants are defined as undesirable plant growth that shall include, but not be limited to all declared category 1, 2 and 3 listed invader species as set out in the Conservation of Agricultural Resources Act (No 43 of 1983) regulations. Other vegetation deemed to be invasive should be those plant species that show the potential to occupy in number, any area within the defined construction area*

1 PURPOSE OF THIS DOCUMENT

The proposed uMkhomazi Water Project Phase 1 (uMWP-1) consists of both raw water and potable water components which are being undertaken by the Department of Water and Sanitation (DWS) and Umgeni Water (UW), respectively. Nemai Consulting was appointed as the independent Environmental Assessment Practitioner (EAP) to undertake the Environmental Impact Assessment (EIA) for both components of the uMWP-1.

The then Department of Environment, Forestry and Fisheries (now the Department of Forestry, Fisheries and the Environment – DFFE) issued two Environmental Authorizations (EAs) in November 2020. An Environmental Authorizations (EA) for the construction of the Smithfield Dam and its associated infrastructure was issued and another for the water conveyance infrastructure consisting of a tunnel and raw water pipeline.

DWS (Applicant) subsequently applied for amendments to the above EAs. DFFE approved most of the proposed amendments to the conditions in September 2021.

This document serves as the **Environmental Management Programme** (EMPr) for the **pre-construction phase only of the Smithfield Dam and its associated infrastructure**. It was developed in support of the EIA that was undertaken for the project, the EA (**Annexure A**) and the subsequent amendments to the EA (**Annexure B**). Furthermore, this EMPr was compiled in accordance with Appendix 4 of Government Notice (GN) No. R 982 of 4 December 2014 (as amended).

An approved **Construction and Operation EMPr** will be required prior to the commencement of the main construction activities.

The draft Pre-Construction EMPr was lodged for public review from 6 December 2021 until 26 January 2022. All comments received on the draft document are contained in **Annexure C**.

2 PROJECT BACKGROUND AND MOTIVATION

The current water resources of the Integrated Mgeni Water Supply System (WSS) are insufficient to meet the long-term water requirements of the system. The Integrated Mgeni WSS is the main water source that supplies about five million people and industries in the eThekwini Municipality, uMgungundlovu District Municipality (DM) and Msunduzi Local Municipality (LM), all of which comprise the economic powerhouse of the KwaZulu-Natal (KZN) Province.

The Integrated Mgeni WSS comprises the Midmar, Albert Falls, Nagle and Inanda Dams in KZN, a water transfer scheme from the Mooi River and the newly constructed Spring Grove Dam. The

current system (Midmar, Albert Falls, Nagle and Inanda Dams and Phase 1 of the Mooi Mgeni Transfer Scheme Phase 1 and 2) has a stochastic yield of 394 million m³/a (measured at Inanda Dam) at a 99% assurance of supply. However, this will not be sufficient to meet the long-term requirements of the system.

Pre-feasibility investigations indicated that the development of the undeveloped uMkhomazi River, to transfer water to the existing Mgeni system, most likely will fulfil this requirement. The uMkhomazi River is the third-largest river in KZN in terms of mean annual runoff.

The uMWP-1 consists of both Raw Water and Potable Water components, which are being undertaken by the DWS and Umgeni Water, respectively (refer to a simplified diagrammatic representation of the overall transfer scheme in **Figure 1** below).

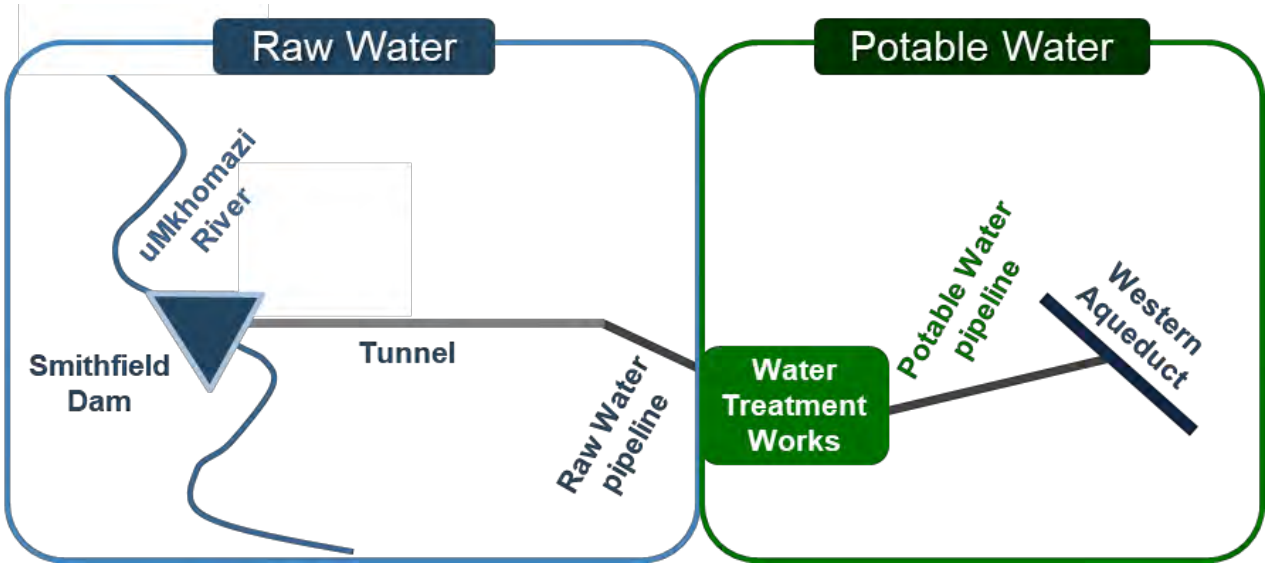

Figure 1: Simplified Diagram of uMWP-1 Components

The proposed uMWP-1 Raw Water Component consists of the following, based on the outcomes of the Technical Feasibility Study (detailed project description provided in the uMWP-1 Raw Water EIA Report):

- Smithfield Dam (81 m high) on the uMkhomazi River, near Bulwer in KZN, with a Full Supply Level (FSL) of 930 masl, including associated infrastructure.
- Water Conveyance Infrastructure:
  - A transfer tunnel (known as the uMkhomazi-uMlaza Tunnel) with an approximate length of 32.5 km (depending on the final route along the tunnel corridor), an inside diameter of 3.5 m and a peak discharge of 8.65 m³/s, conveying water from the proposed Smithfield Dam to the uMlaza River Valley; and
  - A raw water pressure pipeline from the tunnel outlet to the Water Treatment Plant (WTP), with an approximate length of 5.2 km (depending on the final route along the pipeline corridor), an internal diameter of 2.6 m and peak discharge of 8.65 m³/s.

This Document only focuses on the uMWP-1 Raw Water Component with specific reference to the pre-construction activities related to the Smithfield Dam and the associated infrastructure (DFFE Ref: 14/12/16/3/3/3/94).

3 PROJECT LOCATION

The preferred layout for the Smithfield Dam and associated infrastructure, as established through the EIA and additional assessments as part of the first and second Addenda, is shown in **Figure 2** below.

The project area is situated in the southern part of KZN. The Smithfield Dam and the associated infrastructure fall within the Harry Gwala DM and Dr Nkosazana Dlamini Zuma LM as well as the uMgungundlovu DM and Impendle LM. The western portion of the project area is falls under Traditional Authority and state land. The area is characterised by traditional homestead settlements and rural subsistence agriculture.

The proposed Smithfield Dam is located 2 km upstream from the confluence of the uMkhomazi and Mfeneni Rivers, along the middle reaches of the uMkhomazi River, midway between Lundy's Hill Bridge and Deepdale.

The location of the project infrastructure was influenced by various factors, such as topography and associated elevation, impacts to the receiving environment, existing servitudes, existing structures and infrastructure, access, site constraints and geotechnical conditions (amongst others). From a technical perspective, a primary determinant in siting the infrastructure was ensuring the correct elevation to maintain a gravity fed system.

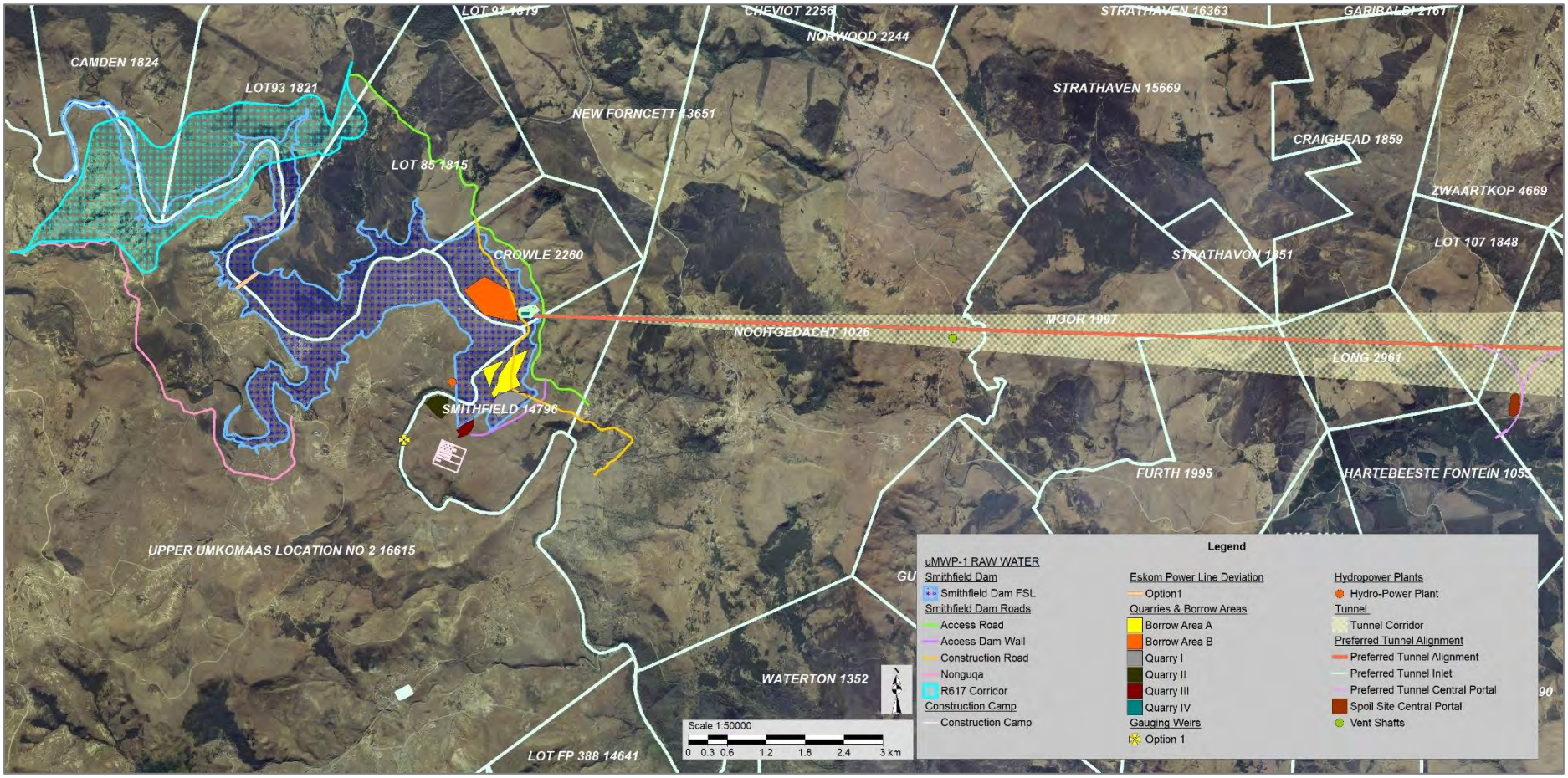

Figure 2: **Locality Map of Preferred Layout – uMWP-1 Raw Water (western side)**

*(Note: **Tunnel** - access to shafts and central portal for preferred tunnel alignment not shown; **Cadastal** – farm portions not shown)*

4 OVERVIEW OF THE DAM AND ASSOCIATED INFRASTRUCTURE

The various components of Smithfield Dam and associated infrastructure are listed in **Table 2** below (refer to **Figures 2 – 3** above).

Table 1: uMWP-1 Smithfield Dam and associated infrastructure (preferred layout)

Raw Water Component	Associated Infrastructure
Major Storage Dam (Smithfield Dam)	1. Dam embankment 2. Saddle dam embankment 3. Spillway (including approach area and plunge pool) 4. Tunnel intake tower 5. Dam and outlet works (including dam wall, dam intake tower, outlet valve house, construction roads, and operator's offices and houses) 6. Relocation of Eskom Transmission Line 7. Relocation of telephone lines 8. Quarries and borrow areas 9. Substation 10. Gauging weir 11. Hydropower plant 12. Spoil sites 13. Construction houses 14. Deviation of the R617 and the construction of a new bridge over the uMkhomazi River 15. Access roads (Nonguqa, intake tower, tunnel inlet portal, dam, gauging weirs)

5 PRE-CONSTRUCTION EMPr

This Pre-Construction EMPr provides performance criteria required to address potential environmental impacts during the pre-construction phase and must be read in conjunction with the EIA Report (November, 2016), as well as the First Addendum to the EIA Report (July, 2018) and Second Addendum to the EIA Report (February, 2020), Environmental Authorisation (November 2020), and first amendments to the Environmental Authorisation (September, 2021).

The Pre-Construction EMPr:

- Establishes management objectives during the pre-construction phase to enhance benefits and minimise adverse environmental impacts;
- Provides targets for management objectives, in terms of desired performance; and
- Describes actions required to achieve management objectives.

6 ROLES AND RESPONSIBILITIES

6.1 DFFE

The DFFE is the mandated authority in terms of NEMA that determines whether an authorisation can be issued for the project, following a decision-making process as conducted as part of the EIA. Conditions are included in the EA and EMPr, which need to be complied with by the project applicant. DFFE also fulfils a compliance and enforcement role with regards to the EA and EMPr. Any amendments that may be required to the EA and and/or EMPr, based on adaptive management to site conditions and the technical requirements of the project must be submitted to DFFE following the required process. This Pre-Construction EMPr will require approval from DFFE prior to any of the activities as listed taking place.

6.2 DWS

The Department of Water and Sanitation (DWS) is the applicant in terms of NEMA. DWS is also referred to as the project proponent. DWS has transferred the accountability of meeting the requirements of the EMPr and EA to TCTA, who is the implementing agent. This relationship was formalised in May 2018 when the Minister of Water and Sanitation issued a directive to TCTA fund and implement uMWP-1. TCTA is therefore responsible for the implementation of the EMPr and ensuring that the conditions in the EA are satisfied. DWS is accountable for the implementation of all environmental management requirements during the operation and maintenance of the infrastructure.

6.3 TCTA

The Trans-Caledon Tunnel Authority (TCTA) is the state-owned entity, established by Government Notice No 2631 of 12 December 1986 for “the implementation, operation and maintenance of the project works within South Africa” according to the Treaty that governs the Lesotho Highlands Water Project (LHWP). Today TCTA has grown to become a specialised liability management body set up to finance and oversee the creation of bulk raw water infrastructure for the National Government on behalf of the people of South Africa.

TCTA is the implementing agent for the development, as directed by the Minister of Water and Sanitation. The responsibility for environmental compliance rests with the TCTA and includes *inter alia* the following:

- Implementation of the approved Pre-Construction EMPr.
- Submission of any substantial changes, updates or amendments to the Pre-Construction EMPr and/or EA to DFFE for approval.

- Ensuring that the provisions of the EA and Pre-Construction EMPr are binding on all contractors and service providers undertaking any of the pre-construction activities.
- Complying with all applicable environmental laws, regulations, standards and guidelines, and ensuring that the contractors and service providers accepts responsibility to do likewise.
- Being committed to the principles contained within NEMA, including sustainable development and the prevention of pollution and environmental degradation.

TCTA will comply with all applicable laws, regulations, standards and guidelines and will ensure that all professional service providers/contractors accept the responsibility to do likewise. This EMPr together with the EA and approved amendments will therefore form part of any contract between TCTA and its service providers appointed to undertake the pre-construction studies.

All monitoring will be conducted by TCTA in compliance with the requirements of the EA, and this Pre-Construction EMPr. Furthermore, TCTA has to comply with the stringent lender requirements in the loan covenants. These are not only audited internally, but also annually by the Auditor General of South Africa. An Environmental Control Officer (ECO) will not be appointed to monitor the pre-construction phase as this is of a temporary duration.

7 SENSITIVE ENVIRONMENTAL FEATURES

This Section highlights the key sensitive environmental features that were identified in the EIA. This is presented at a fairly high level as this will be verified through the 'Environmental Walk-Through Survey' described in **Section 10.6** below. Thereafter detailed maps will be prepared identifying highly sensitive environmental features and in instances where this cannot be avoided or mitigated, suitable replacement habitats and/or offset requirements will be provided. This detail will be included in the site-specific plans, i.e. Search Rescue and Relocation; Rehabilitation Management; and Biodiversity Offsets and Compensation.

The stands of *Protea caffra* are regarded as an important habit for the threatened *Capys penningtoni*, a threatened butterfly species (Pennington's Protea Butterfly). The sensitive areas and buffer zones are depicted in **Figure 3** below.

All natural and untransformed habitat within what has been termed an "invertebrate corridor" is classified as highly sensitive and has been mapped accordingly in **Figure 4** below.

Whilst these delineations provide the basis for the site survey, it must be noted that the entire construction footprint will be assessed to identify all possible species and habitats of concern. Whilst no *Gnomeskelus fluvialis (Riverine keeled millipede)* has been detected in the aera since 1959, special attention will be paid to this species due to the suitability of habitat for its occurrence along the uMkhomazi River.

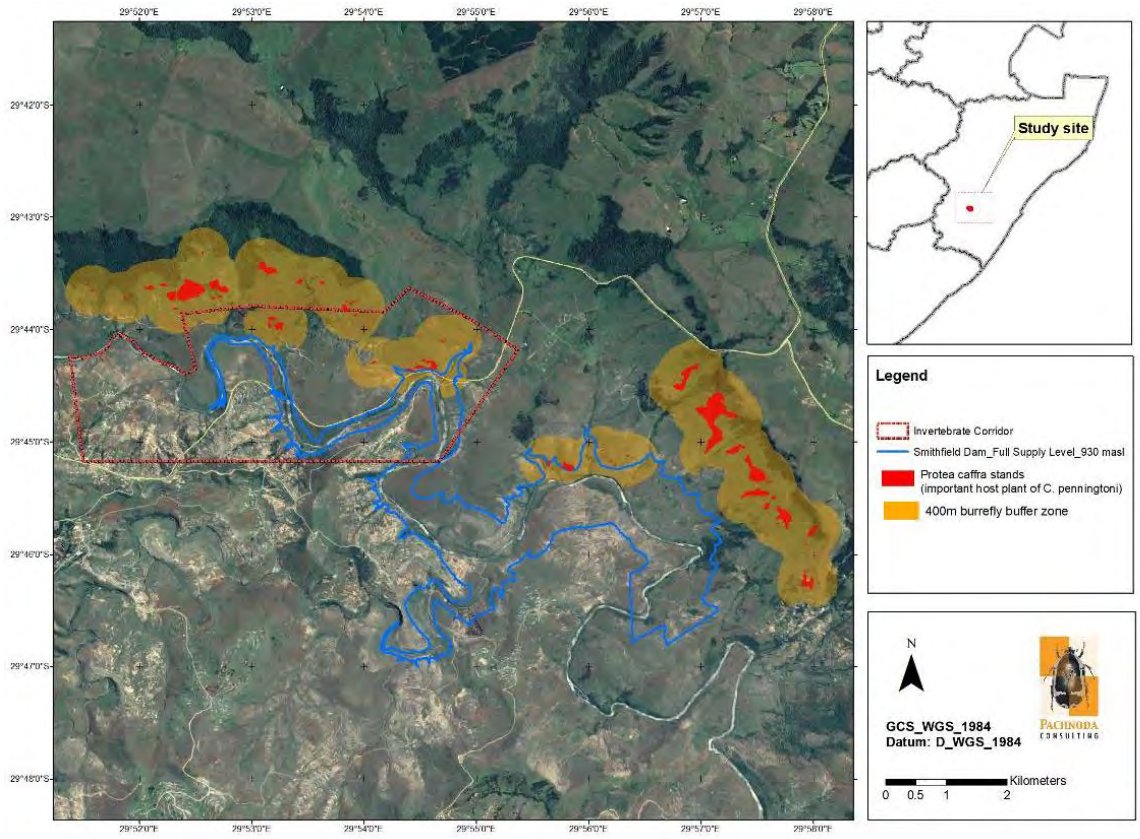

Figure 3: **Spatial position of potential breeding habitat (*Protea caffra* stands) for *Capys penningtoni***

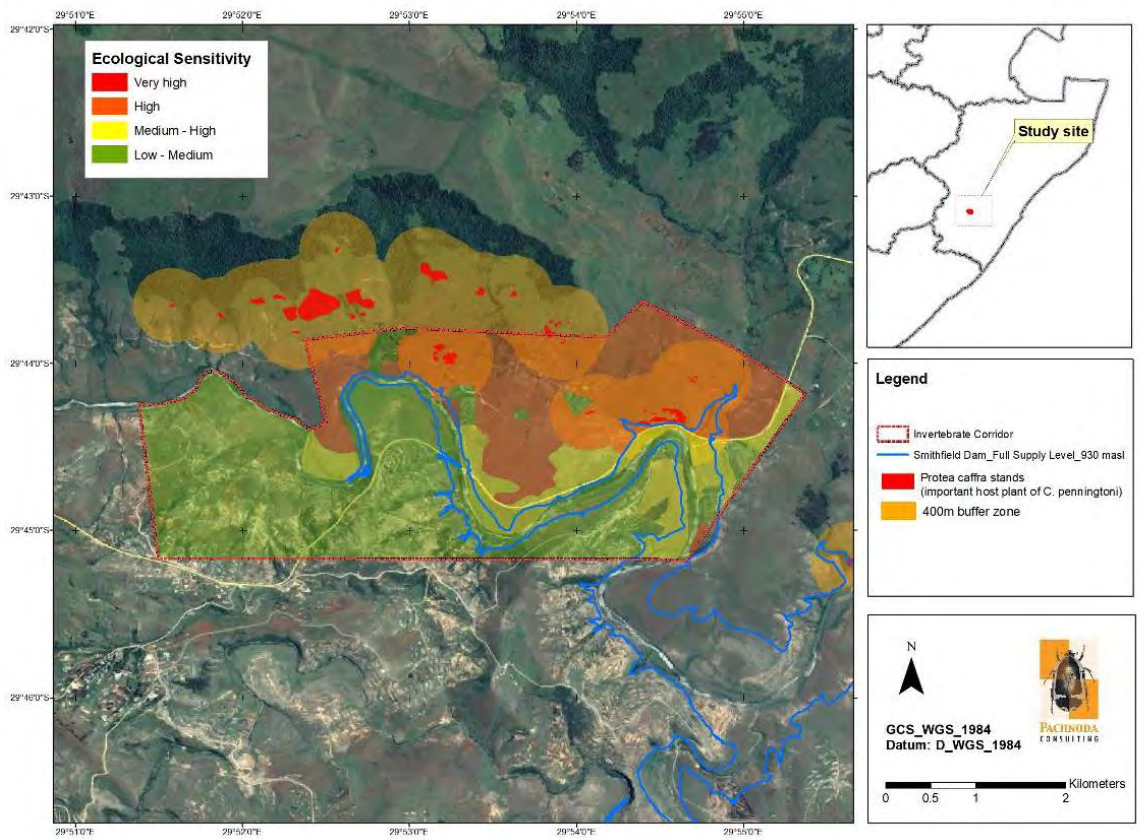

Figure 3: **Sensitivity map of the "invertebrate corridor"**

8 ENVIRONMENTAL ASSESSMENT PRACTITIONER

Nemai Consulting was appointed by DWS as the independent EAP to undertake the EIA for the proposed uMWP-1 Raw Water. Nemai Consulting is an independent, specialist environmental, social development and Occupational Health and Safety (OHS) consultancy, which was founded in December 1999. The company is directed by a team of experienced and capable environmental engineers, scientists, ecologists, sociologists, economists and analysts. The company has offices in Randburg (Gauteng) and Durban (KZN).

The core members of Nemai Consulting that were involved with compiling the EMPr for the project are captured in **Table 2** below, and their respective Curricula Vitae are contained in in the body of the EIA Report.

Table 2: EMPr Core Team Members

Name	Qualifications	Experience
Mr D. Henning	MSc (Aquatic Science)	20 years' experience. Prepared Environmental Management Plans (EMP's) and EMPr's, as well as acted as the Environmental Control Officer (ECO) on various projects, including: • 80 km bulk water pipeline from Randfontein to Rustenburg, North-West; • Construction of the Spring Grove Dam, as part of the Mooi-Mgeni Transfer Scheme Phase 2, KZN; • Ncwabeni Off-Channel Storage and associated infrastructure, KZN; • Mokolo Crocodile West Water Augmentation Project (water transfer scheme), Limpopo Province; and • Foxwood Dam and associated infrastructure, Eastern Cape.
Mr C. Chidley	• BSc Eng (Civil) • BA (Economics, Philosophy) • MBA	25 years' experience. Prepared EMP's and acted as the ECO on various projects, including: • Raising of Hazelmere Dam, KZN; • Upgrade of the Sunderland Ridge Waste Water Treatment Works and bulk sewer line situated on the Hennops River, Gauteng; and • Empangeni Bulk Outfall Sewer, 40 km pipeline, KZN.

9 ENVIRONMENTAL GOVERNANCE FRAMEWORK

9.1 Legal Framework

Pre-construction activities will be undertaken according to recognised best industry practices and will include measures prescribed within this EMPr. The EMPr is a legally binding in terms of environmental legislation. As such, this EMPr, and all environmental statutory requirements, shall form part of the contract documents for any service provider appointed to undertake the pre-construction activities (see Section 8 below) and will inform the service provider of their duties in the fulfilment of this Pre-Construction EMPr, with particular reference to the mitigation of environmental impacts.

All pre-construction activities must comply with all relevant South African legislation and regulations. Specific legislation that must be complied with includes, but is not necessarily limited to:

- Constitution of the Republic of South Africa;
- National Environmental Management Act (Act No. 107 of 1998) (NEMA);
- National Water Act (Act No. 36 of 1998);
- Mineral and Petroleum Resources Development Act (Act No. 28 of 2002);
- Mine Health and Safety Act (Act No 29 of 1996);
- National Environmental Management: Biodiversity Act (Act No. 10 of 2004);
- National Environmental Management: Waste Act (Act No. 59 of 2008);
- National Environmental Management: Protected Areas Act (Act No. 57 of 2003);
- National Environmental Management: Air Quality Act (Act No. 39 of 2004);
- National Heritage Resources Act (Act No. 25 of 1999);
- National Veld and Forest Fire Act (Act No. 101 of 1998);
- Environmental Conservation Act (Act No. 73 of 1989);
- Animal Protection Act (Act No. 71 of 1962);
- Conservation of Agricultural Resources Act (Act No. 43 of 1983);
- Hazardous Substances Act (Act No. 15 of 1973);
- Occupational Health and Safety Act (Act No. 85 of 1993);
- Construction Regulations (2014);
- Explosives Act (No. 15 of 2003); and
- Alien and Invasive Species Regulations (2014).

10 PRE-CONSTRUCTION ACTIVITIES

This Section describes the pre-construction activities and identifies any potential impacts, either positive or negative that may occur as a result of any activities associated with the proposed Smithfield Dam and associated infrastructure. All impacts identified must be then prevented, mitigated against or managed. This EMPr strives to provide a comprehensive list of mitigation measures for the pre-construction activities.

The main activities as well as high-level environmental activities undertaken in the pre-construction phase are listed in **Table 3** below.

Table 3: Activities associated with Pre-Construction Phase

Project Phase: Pre-construction
Pre-construction Activities
Detailed geological and geotechnical investigations.

Project Phase: Pre-construction
Survey and map topography for determination of post-construction landscape, rehabilitation and shaping (where necessary).
Baseline survey of existing infrastructure (e.g. existing roads, Eskom, Telkom, etc.).
Conceptual Engineering design.
Environmental Activities
Undertake a walk-through survey of the project footprint by the relevant environmental specialists to identify sensitive environmental features (including *inter alia* red data, protected and endangered species and medicinal plants – detailed Search, Rescue and Relocation Plan; Rehabilitation Management Plan of the construction footprint.
Social Baseline Assessment by relevant specialists to survey and document including amongst others, affected households, livelihoods, crops and livestock, heritage, etc. Relocation Action Plan (RAP).
Develop a detailed Biodiversity Offsets and Compensation Plan including agreements to secure the offset sites.
Permits if protected trees are to be cut, disturbed, damaged, destroyed or removed during construction.
Access to the affected properties, including access control.
On-going consultation with I&APs.
Development of the Construction and Operation EMPr.

10.1 Geological and geotechnical investigations

Management Objective:

- Arrange access to properties.
- Ensure that only areas that are specifically required for the geological and geotechnical surveys are cleared and rehabilitated.
- Ensure suitable management of labour and staff to prevent security-related issues.
- Provide a safe and healthy working environment to labour and staff, and the public by complying with the Occupational Health and Safety (OHS) Act.

Indicators and Targets:

Indicators	Targets
Compliance notices or other forms of sanction by the authorities	None
Avoid sensitive areas	100%
General housekeeping as a function of visual inspections	Full compliance
General waste management, including contamination as a result of ablution facilities as a function of visual inspections	Full compliance
Number of health and safety major incidents	None

Indicators	Targets
Compliance with the OHS Act	100%

A description of the activities undertaken during the geological and geotechnical surveys, including survey method, equipment used, and impacts on properties is described in **Table 4** below.

Reporting and Monitoring Requirements:

- Documentation i.e. OHS Act.
- Public complaints and issues, and responses.
- Specialist report – Geological and geotechnical report.
- Sign-off from landowners once the investigations are complete.

Table 4: Description of typical activities for geophysical and geotechnical surveys

TYPE OF SURVEY	BRIEF DESCRIPTION OF SURVEY METHOD	EQUIPMENT USED	IMPACTS ON PROPERTIES
Test pitting with a Tractor Loader Backhoe (TLB)	A test pit is excavated using a TLB. The test pit is usually 3.5m deep by 1m wide and 3m to 5m long. A staff member enters the pit and describes and samples the soil therein (profiling). The test pit is then backfilled. As some settlement of the soil can be expected the pit is generally backfilled a little higher than the surrounding ground. Each test pit can take between, approximately, 20 minutes to 40 minutes depending on the skill of the operator and how dense or stiff the underlying material is. Care will be taken to avoid sensitive features.	TLB plus accompanying person in a Light Duty Vehicle (LDV) or car.  **Tractor Loader Backhoe (TLB)**	The excavation of test pits requires the excavation several cubic metres soil and replacing the same. An area of approximately 10m by 10m will be disturbed. Care will be taken that the topsoil is placed in a separate stockpile to the sub-soil, and is re-instated on top again. The process will be excavation, profiling and backfilling. No pit will remain open overnight nor left unattended.
Test pitting with a tracked excavator	A test pit is excavated using a tracked excavator which is a larger and more powerful machine than a TLB. The test pit is usually 5m to 6m deep by 1m wide and can be 10m long. A staff member enters the pit and describes and samples the soil therein (profiling). The test pit is then backfilled. As some settlement of the soil can be expected the pit is generally backfilled a little higher than the surrounding ground. Each test pit can take between, approximately, 10 minutes to 30 minutes depending on the skill of the operator and how dense or stiff the underlying material is. Test pits will, only, be excavated with the tracked excavator where suitable foundation conditions were not reached with the TLB. This would, typically, be at river crossings and at sites of potential borrow areas.	Tracked excavator plus accompanying persons in a LDV or car.  **Excavator**	The excavation of test pits requires the excavation several cubic metres soil and replacing the same. An area of approximately 20m by 20m will be disturbed as the depth of the pit is much greater than those excavated by a TLB. However, these deeper pits are usually only excavated at the positions of potential borrow areas or at major crossings where rock has to be proven. Care will be taken that the topsoil is placed in a separate stockpile to the sub-soil, and is re-instated on top again. The process will be excavation, profiling and backfilling. No pit will remain open overnight nor left unattended.

TYPE OF SURVEY	BRIEF DESCRIPTION OF SURVEY METHOD	EQUIPMENT USED	IMPACTS ON PROPERTIES
Rotary Core Drilling	A small diameter hole is drilled to depth using a rig which is driven or skidded into position. A full, cylindrical, sample of the profile drilled through is obtained and this can be logged and sampled for subsequent testing. Drilling can be to a predetermined depth or can be terminated when specific conditions are met such as once 3m of rock have been proven. It can take approximately half a day to establish the machine on site for each borehole. Thereafter the drill rig will need to be on site for the period required complete the drilling to the required depth. In exceptional circumstances the machine may be left on site over a weekend or public holiday(s).	Drilling rig plus accompanying LDV. A water cart will, occasionally visit the rig. Staff will be dropped off at the rig each morning and collected at the end of the working day.  **Typical Drilling Rig**	The drill hole itself is very small. However, a working area is required for drilling and it is necessary to dig a small sump, approximately 1m by 1m and 0.5m deep to allow water and drilling fluids to be recycled and there are drilling rods and core boxes that need to be stored adjacent to the drilling rig.
Soil resistivity survey	This is a non destructive testing method and require small pegs to be hammered into the ground and “wired” up. A small electrical pulse is put through the ground and a receiver picks up the signal along the line of connected pegs. Each survey line will take a few hours to set up and get readings from.	The equipment is, generally, confined to pegs and cables, which are removed after testing. Also, some instrument boxes which are, also, removed after testing. A Light Duty Vehicle (LDV) will be used to deliver the equipment to site.  **Typical resistivity survey activities**	Negligible as only small pegs are driven into the ground and removed once the survey is complete. The only impact will be the survey personnel walking across a property and the LDV which will deliver the equipment to site, using only the farm access roads where these are available.

TYPE OF SURVEY	BRIEF DESCRIPTION OF SURVEY METHOD	EQUIPMENT USED	IMPACTS ON PROPERTIES
Soil Seismic survey	This is a non destructive testing method and require small geophones to be placed on the ground and “wired” up. A small impulse is generated (usually by hitting a steel plate on the ground) causing a shock wave to travel through the ground. The arrival times of the shock wave at the various geophones is recorded. Each survey line will take a few hours to set up and get readings from.	The equipment is, generally, confined to geophones and cables which are removed after testing. Also, some instrument boxes (i.e. recorders) which are, also, removed after testing. A LDV will be used to deliver the equipment to site. Typical seismic survey activities are similar to those for the resistivity survey (see above).	Negligible as only small geophones are placed on the ground and removed once the survey is complete. The only impact will be the survey personnel walking across a property and the LDV which will deliver the equipment to site, using only the farm access roads where these are available.

10.2 Topographical Surveys

A topographical survey locates all surface features showing all natural and man-made features. Specifically, it shows their location, size and levels/elevation. The topographical survey for the project will generally include:

- A three-dimensional digital terrain model (DTM) of the surface (including bathymetry, where required);
- Contour digital orthophotos;
- 2D line mapping of the survey;
- Installation of survey benchmarks and/or control points; and
- Obtaining cadastral information, title deeds and SG diagrams.

Airplanes, helicopters and drones are the most commonly used platforms for acquiring LIDAR data over broad areas. Topographic LIDAR typically uses near infrared laser to map the land, while bathymetric LIDAR uses water-penetrating green light to measure riverbed elevations.

During these surveys, access to properties will be required for the installation of benchmarks and/or control points only.

Management Objective:

- Arrange access to properties.
- Ensure suitable management of labour and staff to prevent security-related issues.
- Provide a safe and healthy working environment to labour and staff, by complying with the OHS Act.

Indicators and Targets:

Indicators	Targets
Compliance notices or other forms of sanction by the authorities	None
Avoid sensitive areas	100%
Number of health and safety major incidents	None
Compliance with the OHS Act	100%

As much of these surveys are aerial, the impacts if any will be minimal.

Reporting and Monitoring Requirements:

- Public complaints and issues, and responses.
- Topographical Survey information and/or model – this information will be used in Concept Engineering Design.

10.3 Baseline Surveys of Existing Infrastructure and Services

Infrastructure and services within the dam wall and basin, and associated infrastructure will require decommissioning and/or removal or realignment before impoundment (filling of the dam basin to crease a reservoir). These include fences, roads, powerlines, buildings, pipelines and septic tanks.

The table below provides a summary of infrastructure and services may require decommissioning or realigned prior to the construction and impoundment.

Table 5: Example of Service/Infrastructure and Requirements

Services/Infrastructure	Construction Activities
Buildings	Demolished and removed, or protected
Roads	Left as is, realigned, deviated, or upgraded
Fences	Demolished and removed
Septic tanks	Opened and filled with un-compacted soil
Electricity and telephone lines	Left as is, relocated or protected
Abstraction works, pump stations and/or pipelines	Disconnected but left *in situ*. Realignment or relocated
Other services	Including *inter alia* fibre optic cables, etc.

Whilst the above construction activities will not be undertaken during the pre-construction phase, it is essential that the existing infrastructure and services are identified and mapped during pre-construction phase.

Management Objective:

- Arrange access to properties.
- Ensure suitable management of labour and staff to prevent security-related issues.

Indicators and Targets:

Indicators	Targets
Compliance notices or other forms of sanction by the authorities	None
Avoid sensitive areas	100%

Monitoring Requirements:

- Public complaints and issues, and responses.
- Existing Infrastructure and Services information - this information will be used in Concept Engineering Design.

10.4 Access and Access Control

The right of access on or around the landowners/farmers private land that are required for the pre-construction activities will be sought from landowners/farmers through negotiation. Generally, permissions for access will be required for small teams/specialists and will be temporary and for a limited period. The access control/protocol we be negotiated and agreed with each landowner/farmer.

Management Objective:

- The access and access control will be in accordance with the EA and this EMPr.

Indicators and Targets:

Indicators	Targets
Access control measures/protocol, i.e. agreement with landowner(s)	Full compliance

Monitoring Requirements:

- Public complaints and issues, and responses.

10.5 Conceptual Engineering design

All of the above pre-construction project activities as well as the environmental activities will inform the conceptual engineering design. This will meet the requirements of Condition 13 of the EA (as amended):

"*A copy of the detailed site layout map must be made available for comments by registered Interested and Affected Parties for a period of 30 days and the holder of this Environmental Authorisation must consider such comments. Once amended, the development layout map must be submitted to the Department for written approval prior to the commencement of construction activities. All available biodiversity information, baseline studies and preconstruction surveys must be used in the finalization of the layout map. The Department will provide written response within a period of 30 days*".

The layout map will include *inter alia* the following:

- Position of the dam and associated infrastructure;
- Internal roads;
- Wetlands, drainage lines, rivers, streams and water crossings;
- Sensitive environmental features;
- Temporary construction laydown areas;
- Borrow pits; and

- Buildings, etc.

10.6 Environmental Walk-Through Survey

The purpose of the survey is to document the flora and fauna that will be affected by the development, including *inter alia:*

- The habitat for:
  - *Capys penningtoni* (Pennington's Protea Butterfly) as a result of the impacts on the stands of their food source, i.e. Protea caffra;
  - Individuals of *Gnomeskelus fluvialis* (Riverine Keeled Millipede), which is only known to occur in the leaf litter of indigenous riparian forest within the uMkhomazi River near Smithfield Dam;
- The terrestrial Critical Biodiversity Areas (CBAs) including Irreplaceable CBAs and Optimal CBAs.
- The wetlands, riparian areas and instream habitat, which are ecologically sensitive and often identified as CBAs.

Management Objectives:

- To identify and document flora and fauna.

Indicators and Targets:

Indicator	Target
Percentage area of search and rescue on the construction area, including licences/permits where required	100%
Alien invasive vegetation control measures documented for the construction area	100%

An ecologist and/or group of specialists (with wetland and rehabilitation experience) will produce an ecological report, which will provide a pre-construction baseline description of the habitats and vegetation types including the siting of faunal species with particular attention to those listed above.

With regards to floral species and habitats, the report must include maps and photographic records per directly affected property and describe the vegetation types as well as:

- Mitigation for threatened/protected species of conservation importance.
- Any protected plants or trees must be documented to ensure that all the necessary permits under the National Forests Act (Act 84 of 1998) can be acquired timeously.
- The alien invasive plant species and weeds that will need to be controlled and the methods of control.

- Detailed and specific rehabilitation (i.e. fertilisers, seed mixes, timing, maintenance, type of applications, etc.) for those areas where rehabilitation will be required.

Monitoring Requirements:

- Public complaints and issues, and responses.
- Information from the survey must be used to prepare the following plans:
  - Search, Rescue, Relocation Management Plan; and
  - Rehabilitation Management Plan.

10.7 The Biodiversity Offsets and Compensation Plan

The EA (as amended) requires that the detailed Biodiversity Offset and Compensation Plan must be approved by the Department **prior to the commencement** of construction commencing on any part or aspect of the development. The footprint lost as described in the EIA Report is summarised in **Table 6** below.

Table 6: Biodiversity features and footprint lost

Project Component	Biodiversity Feature Affected	Footprint Lost		Status
Smithfield Dam basin	CBA Irreplaceable	31 ha	8.7 ha (excluding wetland and riparian vegetation)	Portions of CBA Irreplaceable are along the river (riparian vegetation), on natural grasslands and on steep slopes. In some areas the CBA has been transformed (gravel roads and overgrazing).
	CBA Optimal	176 ha	104 ha (excluding wetland and riparian vegetation)	Portions which fall within CBA Optimal were along the rivers, within natural grassland areas, as well as patches of shrublands. In some areas the CBA has been transformed (agriculture, soil erosion and overgrazing).
	Wetland	55 ha		Wetlands associated with the uMkhomazi River near the proposed Smithfield Dam site include seepages closely associated with the watercourse as well as areas where the side channels show characteristics of valley-bottom wetlands. Floodplain terraces also occur in association with the watercourse. These wetlands fall within an A (natural) PES category.
	Riparian Vegetation	135 ha		Riparian vegetation has retained a relatively good overall PES within this area, although impacted by overgrazing, trampling and some encroachment of exotic vegetation. Functionality remains high, however.
	River	17 km		-

The detailed biodiversity offsets and compensation planning process will include *inter alia* the following:

- Review of the footprint lost or residual impacts (refer to **Table 6** above) and determining the offset targets.
- Develop a detailed plan:
  - Select recipient sites or biodiversity offset areas.
  - Develop detailed scope of work for each site/area - designs, specifications, drawings, budget estimates, cash-flows, etc.
  - Undertake EIAs or apply for exemption where required.
  - Apply for Water Use Licences where required.
  - Conditions for long-term management.
  - Sign agreement with landowner(s).

10.8 Social Baseline Assessment

A Relocation Action Plan (RAP) must be prepared to make suitable provision for the relocation of any dwellings and structures affected by the project and must include the restoration of livelihoods of the affected parties where possible. The survey conducted during the EIA did not cover all affected homesteads, only 12 homesteads have been documented. A Social Baseline Assessment is therefore requirement to inform the RAP. Some of these activities will include *inter alia*:

- The number of households affected and occupation status e.g. contractual right to live on the property, tenancy agreement, number of persons in each house, utilities available and expenses, graves, etc.
- A comprehensive inventory of all dwellings and buildings in the project area that affected (number of living rooms, total floor area, finishing, storage facilities, out buildings, crops and fruit trees, animals, etc.)
- Land requirements e.g. production of maize and other food crops and provision of the loss of land when relocated, livestock grazing area.
- Employment status and proximity to place of employment.
- Access to social services such as medical facilities, school, public buildings, etc.
- Water sources and pipelines for domestic and stock watering; and
- Preferred relocation area, i.e. dwellings/buildings.

11 ENVIRONMENTAL MANAGEMENT REQUIREMENTS

A separate Environmental Awareness Plan has not been prepared for pre-construction activities as there will be a low number of specialists/teams required to access the footprint of the proposed development to undertake the field surveys, studies and investigations. However, strict adherence to this Pre-Construction EMPr will be required at all times and will be contractually binding.

Management Objective:

- To mitigate impacts to environmental features, landowners and existing infrastructure.

Management Actions:

- **Air Quality Management**
  - To minimise dust, the speed limit must be adhered to at all times.
- **Noise Management**
  - To minimise disturbance to surrounding residents and landowners:
    - No amplified music is to be allowed from the use of radios and other devices.
    - Sufficient notice must be provided to the surrounding residents and landowners on any activity that may be a nuisance.
- **Water Management**
  - Working in close proximity to, or in, surface water can pose a risk to the ecological integrity of these resources, potentially to the detriment of the users of water in the resources. It is therefore necessary to ensure that activities that could negatively impact on water resources and water users are effectively managed and controlled to minimise or prevent the same.
  - No hinderance to flow in natural drainage lines.
  - Pre-construction activities not to affect or interfere with downstream water users and ecology.
- **Fire Management**
  - Uncontrollable fires pose risks to health, safety and the environment. No fires will be allowed.
- **Fauna and Flora Management**
  - There are some critically endangered grasslands and functioning wetlands, and other sensitive environmental features. There is also the presence of red data and endangered fauna.
  - Ensure the protection of all animals including livestock.
  - Adhere to agreements made with landowners regarding animals, fences, gates, use of private roads, etc.
  - Have an emergency response procedure for dealing with snake bites, as venomous species may occur in the area.
- **Heritage Management**
  - Care must be taken to avoid damage to, or destruction of, any heritage and cultural sites, graves and archaeological artefacts.
- **Social Management**
  - The project will affect landowners and other interested and affected parties in the area. All interested and affected parties will need to be (i) kept updated on status of pre-construction activities (ii) given the opportunity to raise issues or request information.

- Establish and maintain communication with interested and affected parties.
- Existing communication channels need to be duly respected and adhered to when engaging with the Traditional Authorities surrounding Smithfield Dam and associated infrastructure.
- Continued liaison with authorities with regards to compliance with the EA and this EMPr.
- Establish and maintain protocol to record and address complaints and issues and provide a single point of contact (suitably qualified person) through whom the interested and affected parties may register queries, issues or complaints.
- Provide all information, especially technical findings in a language that is understandable to the general public. The dominant languages include English and Zulu.

- **Rehabilitation Management**
  - All areas disturbed by pre-construction activities must be rehabilitated as soon as is practically possible. Backfilling of excavations must ensure placement of soil in the order it was removed, i.e. subsoil is deposited first, followed by the topsoil and vegetation. Compact in suitable layer thickness to avoid subsistence or depressions and growth of vegetation.

- **General**

  Some of the general requirements that must be adhered to include *inter alia:*
  - **Ablution facilities:**
    - Provide and maintain sufficient and suitable ablution facilities, where required e.g. portable toilets and ensure that these are removed once the pre-construction activities are complete.
    - Toilets may not be situated within 100 m of any water body or within the 1:100 year flood line, exceptions should, however, be allowed when the works are in the water body or in close proximity of the water body – in this instance mobile toilets may be situated at least 50 m away from the water body.
    - All temporary / portable / mobile toilets shall be secured to the ground to prevent them from toppling over due to wind or any other cause and doors are to be kept closed at all times.
    - All windows and other ventilation openings of the toilets should be fitted with suitable screens to prevent flies and other unwanted flying insects from entering the neighbouring properties.
    - The entrances to the toilets will be adequately screened from public view.
    - Sanitary hygiene bins will be provided for female labour and staff.
    - Toilet paper shall be provided.
    - All ablutions facilities are to be cleaned/emptied on a regular basis, before they are full and contaminate the environment, and the disposal of waste is only at a licensed waste disposal facility.
  - **Management of equipment:**
    - Maintenance and cleaning/washing of equipment (which includes apparatus, machinery, and off-road vehicles) will be performed in such a manner so as to avoid any environmental contamination.
    - Use of drip trays, oil traps or other suitable measures.

- Refuelling (using dripless methods/equipment) or servicing within or close proximity of the natural water resources will not be permitted.

- **Waste management:**
  - Littering is prohibited.
  - Oils spills must be prevented. For accidents/incidents relating to spills, cleaning must be immediate by bagging the contaminated soil and safe disposal thereof.

12 REFERENCES

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forestry, fisheries
& the environment

Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

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PER EMAIL / MAIL

Dear Mr Bester

APPROVAL OF THE PRE-CONSTRUCTION ENVIRONMENTAL MANAGEMENT PROGRAMME (EMPR), FOR THE UMKHOMAZI WATER PROJECT PHASE 1: RAW WATER COMPONENT – CONSTRUCTION OF SMITHFIELD DAM AND ASSOCIATED INFRASTRUCTURE WITHIN DR NKOSAZANA DLAMINI ZUMA, IMPENDLE AND MSUNDUZI LOCAL MUNICIPALITIES IN THE KWAZULU-NATAL PROVINCE

The Environmental Authorisation (EA) issued for the above application by this Department on 18 November 2020, the pre-construction EMPr dated January 2022, for the abovementioned development, received by the Department on 03 February 2022 refer.

This Department has evaluated the pre-construction EMPr and is hereby **approved**. The approved EMPr must be implemented and adhered to. This EMPr approval must be read in conjunction with the conditions contained within the abovementioned EA dated 18 November 2020, as amended.

It is noted that this is the approval for the pre-construction phase of the Smithfield Dam and its associated infrastructure only. The Construction and Operation EMPr must be approved prior to the commencement of the main construction activities.

This EMPr must be regarded as a 'living document', which may be amended from time to time as and when the need arises. For future amendments to this EMPr, your attention is drawn to the processes as outlined in the EIA Regulations, 2014, as amended.

Yours faithfully

Mr Sabelo Malaza
Chief Director: Integrated Environmental Authorisations
Department of Forestry, Fisheries and the Environment
Date: 02/03/2022

cc:	Donavan Henning	Nemai Consulting (Pty) Ltd	Email: donavanh@nemai.co.za
	Ian Felton	KZN Department of Economic Development, Tourism	Email: Ian.Felton@kznedtea.gov.za

M.S

		and Environmental Affairs (EDTEA)	
	Ashantia Nerissa Pillay	Ezemvelo KZN Wildlife	Email: Nerissa.Pillay@kznwildlife.com

AGREEMENT

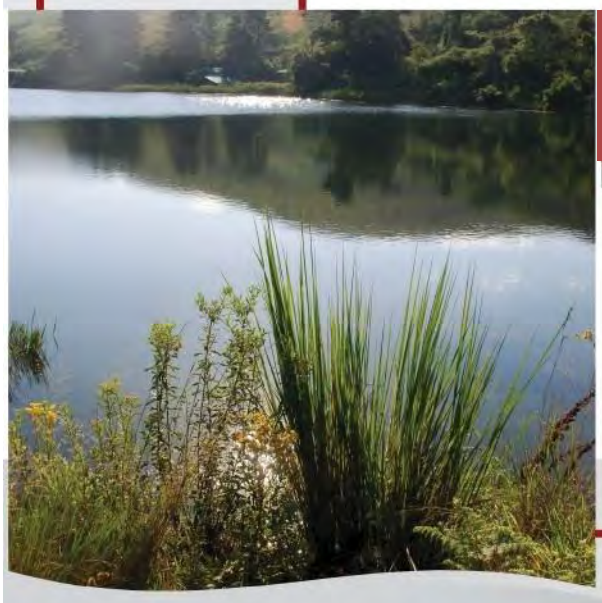
APPENDIX 7: RECORD OF IMPLEMENTATION DECISIONS

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

REPORT NO: P WMA 11/U10/00/3312/1/4

The uMkhomazi Water Project Phase 1: Module 1: Technical Feasibility Study: Raw Water



RECORD OF IMPLEMENTATION DECISIONS

FINAL

MARCH 2018

W112_2013/J01763

P WMA 11/U10/00/3312/1/4

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

The uMkhomazi Water Project Phase 1:

Module 1: Technical Feasibility Study

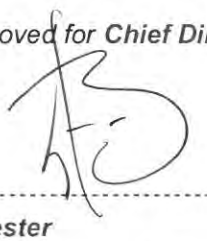
Raw Water

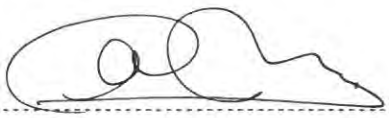
RECORD OF IMPLEMENTATION DECISIONS

Project name:	***The uMkhomazi Water Project Phase 1***
Report title:	***Record of Implementation Decisions***
Authors:	***Directorate: Options Analysis***
DWA Report no.:	***P WMA 11/U10/00/3312/4***
Status of report:	***Final***
First issue:	***June 2017***
Final issue:	***March 2018***

DEPARTMENT OF WATER AND SANITATION (DWS):

*Approved for **Chief Directorate: Integrated Water Resources Planning** by:*



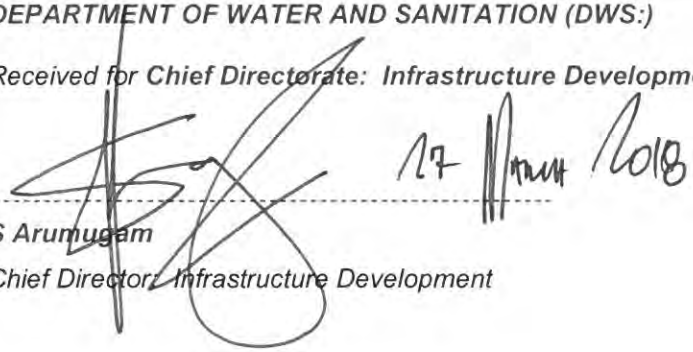


K Bester
Chief Engineer: Options Analysis

LS Mabuda
Chief Director: Integrated Water Resource Planning

DEPARTMENT OF WATER AND SANITATION (DWS:)

*Received for **Chief Directorate: Infrastructure Development** by:*



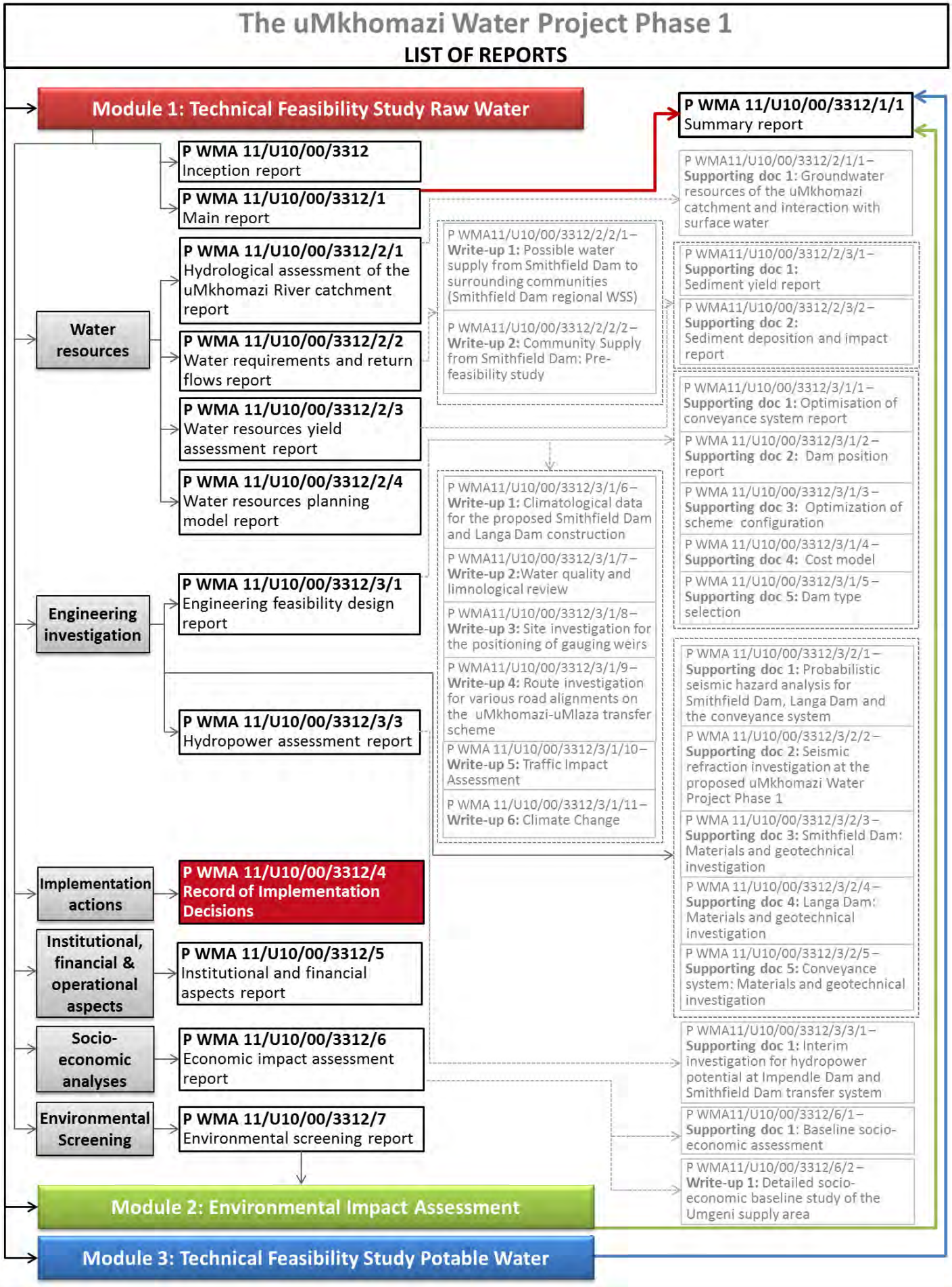
17 May 2018

S Arumugam
Chief Director: Infrastructure Development

PREAMBLE

In June 2014, two years after the commencement of the Technical Feasibility Study for the proposed uMkhomazi Water Project Phase 1 (uMWP-1), a new Department of Water and Sanitation (DWS) was formed by Cabinet, which included the formerly known Department of Water Affairs (DWA).

In order to maintain consistent reporting, all reports emanating from the uMWP-1: Module 1: Technical Feasibility Study: Raw Water will be published under the DWA name.


The uMkhomazi Water Project Phase 1
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P WMA 11/U10/00/3312/3/1/11 – Write-up 6: Climate Change
P WMA11/U10/00/3312/2/1/1 – Supporting doc 1: Groundwater resources of the uMkhomazi catchment and interaction with surface water
P WMA11/U10/00/3312/2/3/1 – Supporting doc 1: Sediment yield report
P WMA11/U10/00/3312/2/3/2 – Supporting doc 2: Sediment deposition and impact report
P WMA11/U10/00/3312/3/1/1 – Supporting doc 1: Optimisation of conveyance system report
P WMA 11/U10/00/3312/3/1/2 – Supporting doc 2: Dam position report
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P WMA 11/U10/00/3312/3/2/1 – Supporting doc 1: Probabilistic seismic hazard analysis for Smithfield Dam, Langa Dam and the conveyance system
P WMA 11/U10/00/3312/3/2/2 – Supporting doc 2: Seismic refraction investigation at the proposed uMkhomazi Water Project Phase 1
P WMA 11/U10/00/3312/3/2/3 – Supporting doc 3: Smithfield Dam: Materials and geotechnical investigation
P WMA 11/U10/00/3312/3/2/4 – Supporting doc 4: Langa Dam: Materials and geotechnical investigation
P WMA 11/U10/00/3312/3/2/5 – Supporting doc 5: Conveyance system: Materials and geotechnical investigation
P WMA11/U10/00/3312/3/3/1 – Supporting doc 1: Interim investigation for hydropower potential at Impendle Dam and Smithfield Dam transfer system
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BBBEE	Broad-Based Black Economic Empowerment
CD	Chief Directorate / Chief Director
DBT	Drill and Blast Technique
DEA	Department of Environmental Affairs
DM	District Municipality
DMR	Department of Mineral Resources
DWA	Department of Water Affairs (previously Department of Water Affairs and Forestry)
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation (previously Department of Water Affairs)
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
ECRD	Earth Core Rockfill Dam
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EKZNW	Ezemvelo KZN Wildlife
EMC	Environmental Monitoring Committee
EMP	Environmental Management Plan
EMPr	Environmental Management Programme
EWR	Environmental Water Requirements
FSL	Full Supply Level
HPP	Hydropower Plant
I&APs	Interested and Affected Parties
ID	Infrastructure Development
IWRP	Integrated Water Resources Planning
KZN	KwaZulu-Natal Province
KZN EDTEA	KZN Economic Development, Tourism and Environmental Affairs
LM	Local Municipality
MAR	Mean Annual Runoff
MM	Metropolitan Municipality
MMTS-1	Mooi Mgeni Transfer Scheme Phase 1
MMTS-2	Mooi Mgeni Transfer Scheme Phase 2
MoA	Memorandum of Agreement
MOL	Minimum Operating Level
ND	Nominal Diameter
NOC	Non Overspill Crest
NWA	National Water Act (Act No. 36 of 1998)
NWRI	National Water Resources Infrastructure
O&M	Operation and Maintenance

PCC	Project Coordination Committee
PMC	Project Management Committee
PMF	Probable Maximum Flood
PPP	Public Participation Process
PR	Public Relations
Project	uMkhomazi Water Project Phase 1 (uMWP-1)
RAP	Relocation Action Plan
RCC	Roller Compacted Concrete
RDF	Recommended Design Flood
RI	Recurrence Interval
RID	Record of Implementation Decisions
RL	Reduced Level
RMF	Regional Maximum Flood
RPF	Relocation Policy Framework
SABS	South African Bureau of Standards
SANS	South African National Standards
SEF	Safety Evaluation Flood
TBM	Tunnel Boring Machine
TC	Technical Committee
TCTA	Trans-Caledon Tunnelling Authority
TEC	Target Ecological Class
uMWP	uMkhomazi Water Project
uMWP-1	uMkhomazi Water Project Phase 1
uMWP-2	uMkhomazi Water Project Phase 2
UW	Umgeni Water
VAT	Value Added Tax
WSA	Water Services Authority
WSS	Water Supply System
WTP	Water Treatment Plant
WULA	Water User Licence Application
WWTP	Waste Water Treatment Plant

LIST OF UNITS

Ha	Hectare
km	Kilometre
km^2	Square kilometre
kVA	Kilovolt-ampere
m	Metre
m^3	Cubic metre
m^3/a	Cubic metre per annum
m^3/s	Cub meter per second
masl	Metres above sea level
MW	Megawatt
$t/km^2/a$	Ton per square kilometre per annum

1 INTRODUCTION

The Department of Water and Sanitation (DWS) explored options to meet the long-term water requirements of the more than five million domestic and industrial water users in the eThekwini and Pietermaritzburg regions of the KwaZulu-Natal Province (KZN), also known as the economic hub of the KZN. The fully developed Mgeni Water Supply System (WSS), the main water source of this area, can be augmented by the uMkhomazi River, with dams at Smithfield and Impendle, transferring the water via a tunnel and pipelines to the Umgeni Water (UW) bulk distribution system at Umlaas Road.

The feasibility planning layout and sizing of the proposed uMkhomazi Water Project Phase 1 (uMWP-1) were undertaken as part of the **uMkhomazi Water Project Phase 1: Module 1: Technical Feasibility Study: Raw Water**.

The Department of Environmental Affairs' (DEA's) approval of the Environmental Impact Assessment (EIA) Report and Environmental Authorisation (EA) are still pending for the Project (the uMWP-1). Furthermore, the EA Process for the quarries and borrow areas for the Project, which is administered by the Department of Mineral Resources (DMR) is not completed. The Final EIA Reports for the uMWP-1's Raw Water and Potable Water Components were submitted to the DEA during November 2016. The DEA, however, requested additional information to conclude the decision-making process. The DEA's decision is expected by October 2018 and the DMR's decision is expected by July 2018.

The initial proposed realignment options for Provincial Road R617 by the Technical Feasibility Study are not acceptable to the KZN Department of Transport mainly due to substandard geometrics, specifically the steep slopes. During the EIA Process Ezemvelo KZN Wildlife (EKZNW) indicated that it will not be problematic if the re-aligned Provincial Road R617 traverse the southern parts of Impendle Nature Reserve. After the EIA Report has been submitted EKZNW indicated that they have a problem in principle with allowing development in any nature reserve For these reasons the investigation of alternative alignment options for the Provincial Road R617 are currently underway. The Implementing Agent should also consider and evaluate the proposed alignment option/s for the Provincial Road R617 in more detail.

The tunnel alignment might have to be changed in order to avoid tunnel construction beneath the critically endangered Blue Swallows nesting sites, and alternative tunnel alignment investigations are currently underway. The balancing dam option (the proposed Langa Dam), and/or the position of this dam, might also change. Furthermore, there might also be other possible technical changes, and changes to the scheme layout.

2 THE RECORD OF IMPLEMENTATION DECISIONS

A Memorandum of Agreement (MoA) between the Chief Directorates Integrated Water Resources Planning (IWRP) and Infrastructure Development (ID) dated March 2005, clarifies that "*the division and/or sharing of roles, responsibilities and accountability of the Chief Directorates through the various project phases from planning to the commissioning of a project*".

This memorandum states that once the detailed planning of a project has been concluded, and the scheme configuration and other related requirements for implementation have been approved by the Minister, the project shall be formally handed over from the Chief Directorate (CD): IWRP to the CD: ID for implementation. This formal handing-over of the project is concluded through an official document namely, the Record of Implementation Decisions (RID), and is signed off by responsible officials from both the CD: IWRP and the CD: ID. The RID summarises all decisions as approved; describes the scope of the project; the specific configuration of the scheme to be implemented; the required implementation timelines; the financing arrangements; the finalisation of required institutional arrangements and the required environmental mitigation measures as described in the Environmental Impact Report (EIR) as well as any further requirements that may be prescribed by the EA from the DEA. Any work performed outside the scope of the RID will be considered unauthorised work unless official approval for such work has been obtained from the CD: IWRP prior to such work being performed.

This document is the Record of Implementation Decisions (RID) for initiating preparatory work of the **uMWP-1** by the Implementing Agent.

The formal RID for implementation of the **uMWP-1** will be finalised by the DWS when the EA has been obtained and when the Project has been gazetted.

3 BACKGROUND TO THE PROJECT

3.1 THE MGENI SYSTEM

The Mgeni WSS supplies the eThekwini Metropolitan Municipality (MM), the Msunduzi Local Municipality (LM) as well as the iLembe; Ugu and uMgungundlovu District Municipalities (DMs). The current water resources of the Mgeni WSS are insufficient to meet the long-term water demands of the system.

The plan layout of both Phases 1 and 2 of the uMkhomazi Water Project (uMWP) is shown on **Figure 3.1** below.

The sources of the Mgeni WSS comprise the Midmar; Albert Falls; Nagle and Inanda dams in the KZN and a Water Transfer Scheme from the Mooi River, which includes the newly constructed Spring Grove Dam, as part of the Mooi Mgeni Transfer Scheme - Phase 2 (MMTS-2). Prior to the implementation of the MMTS-2 the Mgeni WSS, comprised the Midmar; Albert Falls; Nagle and Inanda dams, as well as the Mooi-Mgeni Transfer Scheme Phase 1 (MMTS-1), and had a stochastic yield of 334 million m³/a (measured at Inanda Dam) at a 99% assurance of supply. The short-term augmentation measure, which is the MMTS-2, will increase water supply from the Mgeni WSS by 60 million m³/a. This will however, not be sufficient to meet the long-term requirements of the Mgeni WSS from 2016 onwards.

Investigations indicated that the uMWP-1, which entails the transfer of water from the undeveloped uMkhomazi River to the existing Mgeni WSS, could fulfil this requirement.

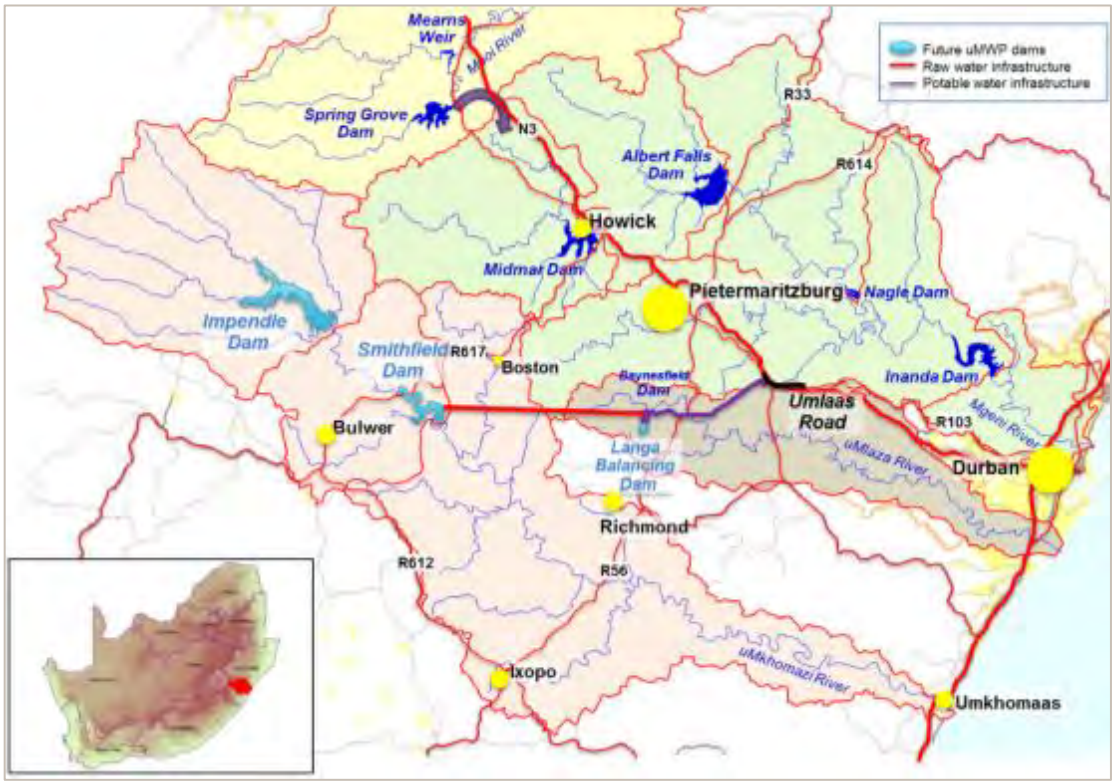


Figure 3.1: Locality of the uMkhomazi and uMgeni Catchments and the Proposed uMWP

3.2 General Description of the uMkhomazi Water Project Phase 1

The main components of the uMWP-1 are the following:

- A new dam at Smithfield on the uMkhomazi River (proposed Smithfield Dam) near Bulwer (refer **Section 4** below);
- Raw water conveyance infrastructure (proposed tunnel and pipelines) (refer **Section 5** below) to the proposed Water Treatment Plant (WTP) in the uMlaza River Valley at Baynesfield (the Baynesfield WTP);
- A balancing dam (refer **Section 6** below) on the Mbangweni River (proposed Langa Dam);
- Other proposed infrastructure such as gauging weirs, hydropower plants, access routes and road deviations (refer **Section 7** below);
- A potable water gravity pipeline from the Baynesfield WTP to the Umgeni Bulk Distribution System, below the reservoir at Umlaas Road. It is recommended that water be distributed under gravity from the reservoir at Umlaas Road to eThekwini, as well as
- A proposed take-off bi-directional raw water pipeline to and from Langa Dam (refer **Section 5** below).

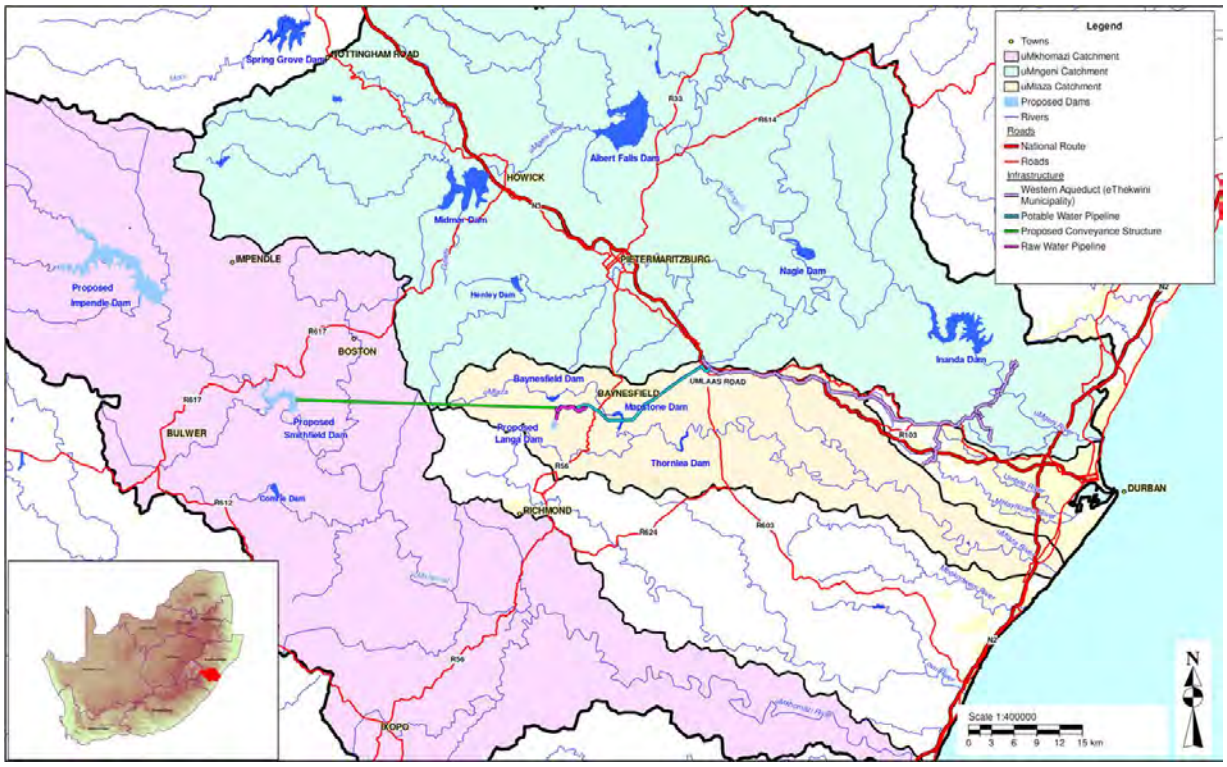


Figure 3.2: Locality Map of the uMWP within the uMkhomazi and uMgeni Catchments

The uMWP Phase 2 (uMWP-2) may be implemented when needed, and could comprise the construction of a large dam at Impendle further upstream on the uMkhomazi River (the proposed Impendle Dam) to release water to the downstream Smithfield Dam to be conveyed to the Mgeni WSS.

Only the uMWP-1 is described further in this report for possible implementation.

3.3 Water Requirements and Balance of the Mgeni Water Supply System

Through a detailed assessment of the demographics and economic growth factors, the projected long-term Mgeni WSS's water requirements were estimated (*Water requirements and return flows report, P WMA 11/U10/00/3312/2/2*), as shown in **Figure 3.3** below. Significant projected economic growth and development in the eThekwini and Msunduzi Municipalities necessitates the implementation of the next Mgeni WSS augmentation scheme after 2016. The projected annual growth in water requirements in the eThekwini and Msunduzi municipal areas is approximated at 1.5% per annum.

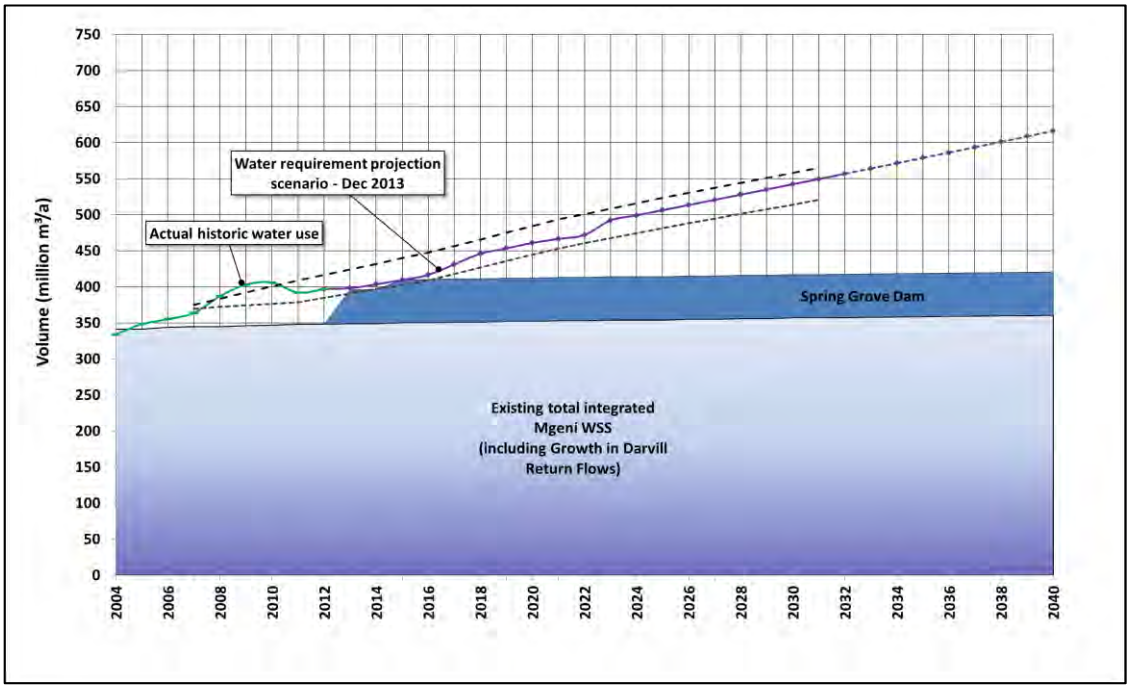


Figure 3.3: Mgeni Water Supply System Water Balance (2013)

3.4 PURPOSE OF THE PROJECT

The purpose of the uMWP (both phases) is thus to augment the yield of the Mgeni WSS for long-term water supply and related economic growth in the eThekwini MM; Msunduzi LM; southern areas of the ILembe DM and northern areas of the Ugu DM.

All uMWP-1 infrastructure components mentioned in the report are only proposed infrastructure.

Although reference is made to UW's Potable Water Infrastructure, this infrastructure is not further described in this document. This document should, however, be read in conjunction with the reports on the *uMWP-1 Module 1: Technical Feasibility Study: Raw Water, Module 2: Environmental Impact Assessment,* and *Module 3: Technical Feasibility Study: Potable Water*. The detail Feasibility Study Reports for the uMWP-1 are listed in **Section 14** below.

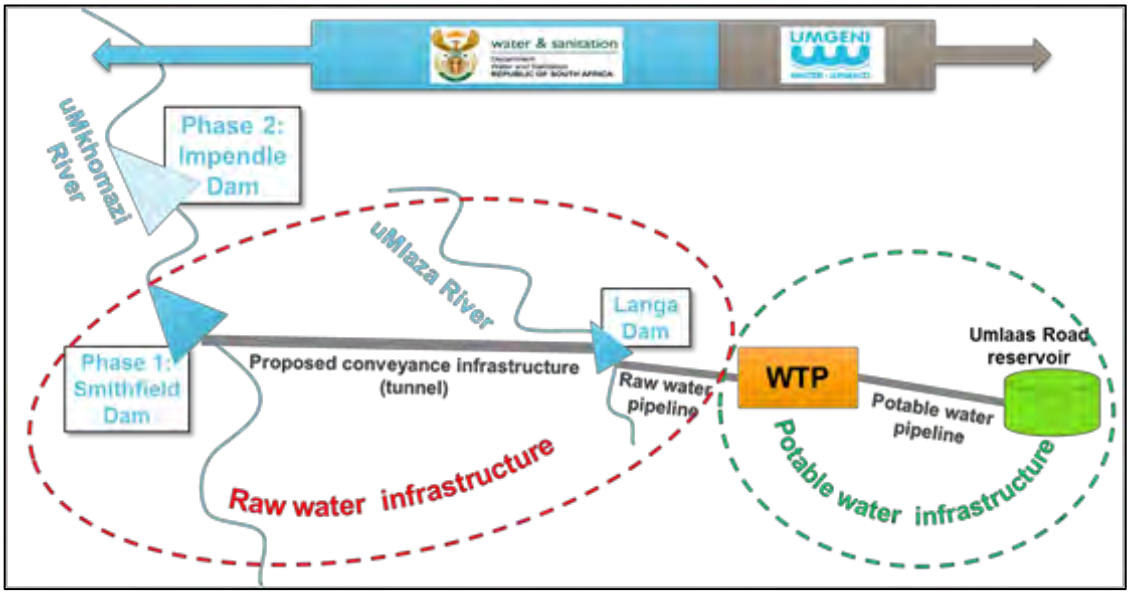


Figure 3.4: Schematic Layout of uMWP-1 Raw and Potable Water Components

Current DWS Guidelines and best practices (refer **Section 9** below) must be applied for the Scope of Work as described hereafter, as well as to develop and manage the implementation of the Project in the most effective and efficient manner and in accordance with all the applicable legislation; guidelines; protocols and current best practices.

4 SCOPE OF WORK FOR THE PROPOSED SMITHFIELD DAM

4.1 LOCATION OF SMITHFIELD DAM

The Smithfield Dam is to be constructed on the uMkhomazi River at the farm **Smithfield**, is situated about 18 km east of Bulwer and about 6 km south-east of where Provincial Road R617 crosses the uMkhomazi River, as shown in **Figure 4.1** below. The coordinates of the point where the centreline of the dam intersects the river are: **Latitude: 29° 46' 30.31"S, Longitude: 29° 56' 39.43"E**.

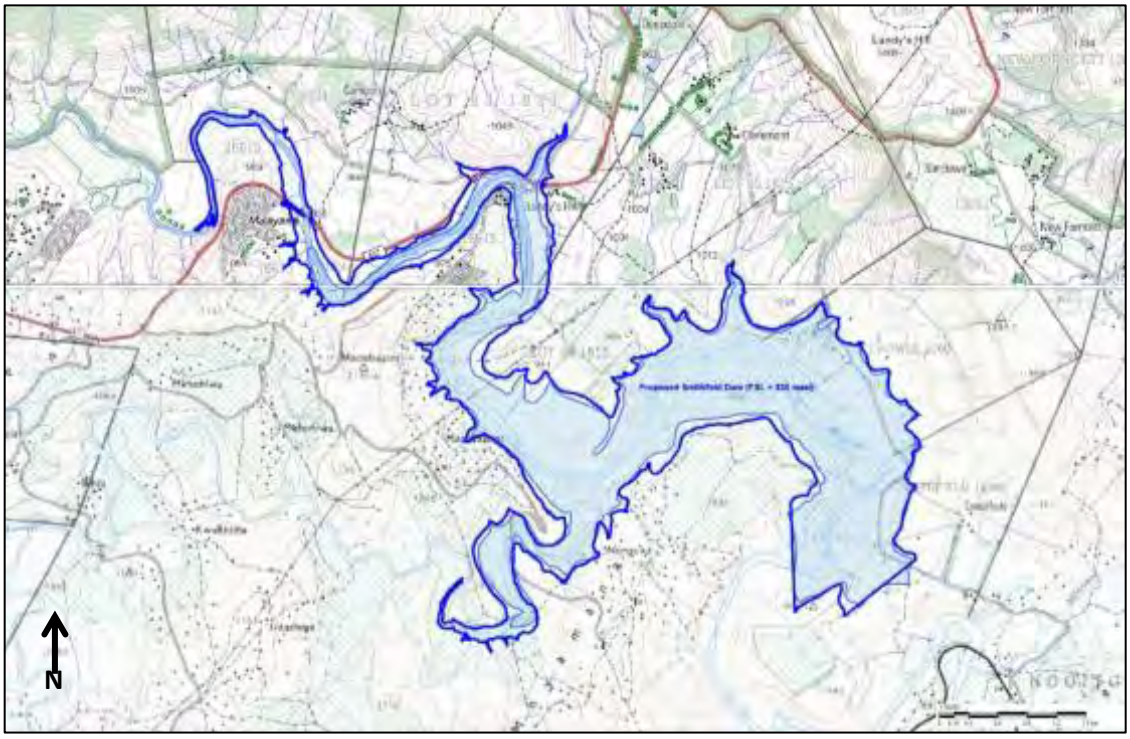


Figure 4.1: Location of Smithfield Dam

4.2 WATER RESOURCE DETAIL

4.2.1 Dam Yield and System Demands

It is estimated that the natural Mean Annual Runoff (MAR) at the proposed Smithfield Dam Site is 725.9 million m³/a (for the period 1925 to 2008, hydrological years).

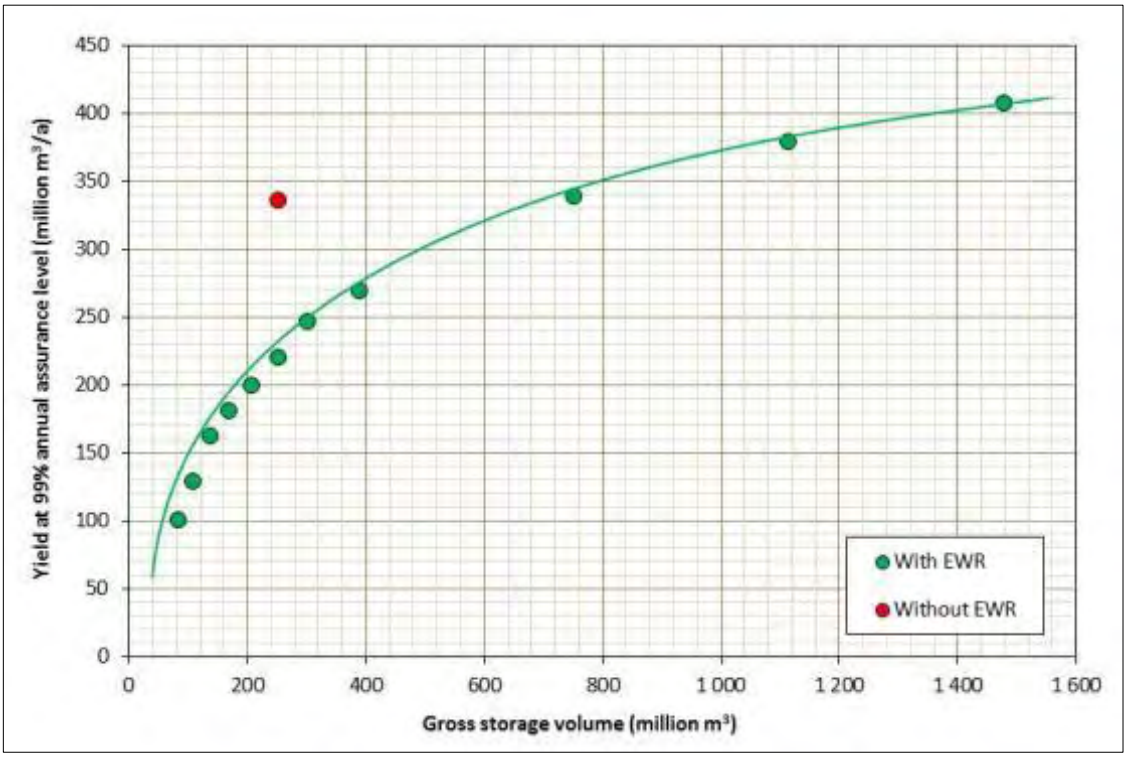


Figure 4.2: Yield for Smithfield Dam at the 99% Annual Assurance Level

It is anticipated that Smithfield Dam, will be developed to a Full Supply Level (FSL) of Reduced Level (RL) 930 masl with a gross storage volume of 251.43 million m³, will have a **yield at 99% annual assurance level of 215 million m³/a**, after full provision has been made for releases to support the Environmental Water Requirements (EWR) at EWR Site 1b (*Water resources yield assessment report, P WMA 11/U10/00/3312/2/3*). All yields, shown in **Figure 4.2** above, and given in **Table 4.1** below, are based on analyses undertaken at the 2050 development level, as this roughly coincides with the anticipated implementation date of the uMWP-2 (proposed Impendle Dam and second tunnel).

Table 4.1: Results from the Yield Analyses for a RL 930 masl FSL Smithfield Dam with EWR Releases

FSL (masl)	% MAR (%)	Gross Storage Volume(1) (million m³)	Stochastic yield at selected assurance level (2) (million m³/a)				Historic firm yield (million m³/a)
			95%	98%	99%	99,5%	
With EWR							
930	35	251.43	260	237	215	210	172

Notes: (1) At date of commissioning.
(2) At 2050-development levels

4.2.2 Sedimentation

A sediment yield of 317 t/km^2/a has been estimated for Smithfield Dam in the sedimentation study (*Sediment Yield Report - Supporting Document 1: Water Resources Yield Assessment, P WMA 11/U10/00/3312/2/3/1*). The volume of sediment that will be accumulated in the dam basin after 50 years is estimated to be 22.1 million m^3, which is approximately 8.8% of the dam's gross storage volume.

4.2.3 Flood Hydrology

a) Spillway Design Floods

Smithfield Dam will be a large dam (wall height >30 m) with a high hazard potential (due to extensive downstream developments) and will be classified as a **Category III** dam in terms of the standing Dam Safety Regulations.

Flood hydrographs, obtained from the *Engineering Feasibility Design Report (P WMA 11/U10/00/3312/3/1)*, with the following flood peaks were selected to size the spillway and freeboard in terms of the Recommended Design Flood (RDF); Safety Evaluation Flood (SEF); Regional Maximum Flood (RMF) and Probable Maximum Flood (PMF).

- RDF - 1:200 year Recurrence Interval (RI) 2 620 m³/s
- RMF 4 540 m³/s
- SEF = RMF+Δ 5 650 m³/s
- PMF 6 185 m^3/s

b) River Diversion Design Floods

The appropriateness of the proposed selected flood diversion criteria should be reviewed during the detailed design phase, and must be approved by the DWS as well as by the Approved Professional Person (APP) for the dams (Smithfield and Langa dams).

4.2.4 uMkhomazi-Mgeni System Water Resources Operating Rules

During the implementation phase of the uMWP-1 detailed operating rules for the system must be defined and established by the Operating Entity.

4.2.5 Ecological Reserve

Water needs to be released to supply the EWR Site 1b, located directly downstream of the dam site, and equates to an average requirement of 228 million m^3/a (or 31.4% of the natural MAR). EWR Mvoti to UMzimkhulu Water Management Area in detail in the *Water resources yield assessment report (P WMA11/U10/00/3312/2/3)*.

The operating rules for the EWR releases will be informed by the outcomes of the *Classification of Water Resources and Determination of the Comprehensive Reserve and Resources Quality Objectives in the Mvoti to UMzimkhulu Water Management Area (DWA, 2015/16)* ***and must be established by the Operating Entity in accordance with the statutory requirements, and according to the developed EWR Rule Table.*** The Target Ecological Classes (TECs) and EWR in the Mvoti to UMzimkhulu Water Management Area were also Gazetted in Government Gazette No. 40075 dated 17 June 2016.

4.2.6 Mgeni WSS Augmentation Requirements

Smithfield Dam will supply the water required to augment the Mgeni WSS, based on the Mgeni WSS water requirements growth curve as shown in **Figure 4.2** above. The Operating Entity within the integrated Mgeni WSS will manage these requirements.

4.2.7 Permanent Water Supply Infrastructure at Smithfield Dam

A reasonable amount of water of about 1 million m^3/a should be allocated for supply to the communities surrounding Smithfield Dam. This is, however, the responsibility of the Water Services Authority (WSA) and not part of the Implementing Agent's Directive.

4.2.8 Existing Water Entitlements in the Dam Basin

All the existing water users from the uMkhomazi River Catchment were taken into account, and an operating rule should be developed by the Operating Entity for the support of downstream users, which must also cater for future development up to 2050.

4.3 DAM CHARACTERISTICS

This section gives a brief description of Smithfield Dam, which is described in more detail in **Section 3** of the *Engineering Feasibility Design Report (P WMA 11/U10/00/3312/3/1)*.

The stage-storage volumes and surface area relationships from the available contour map for Smithfield Dam are shown in **Figure 4.3** below.

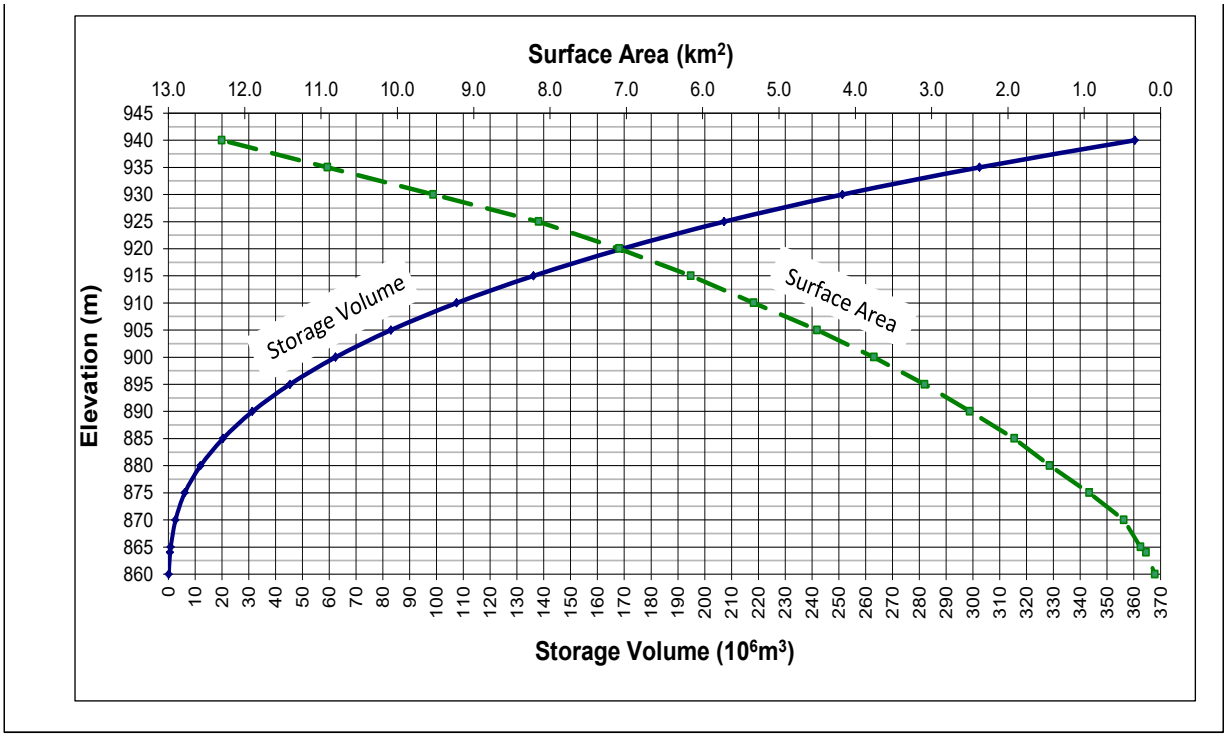


Figure 4.3: Storage Volume and Surface Area Curves for Smithfield Dam

The layout of, and principal data for Smithfield Dam is shown and summarised in **Figure 4.4** and in **Table 4.2** below.

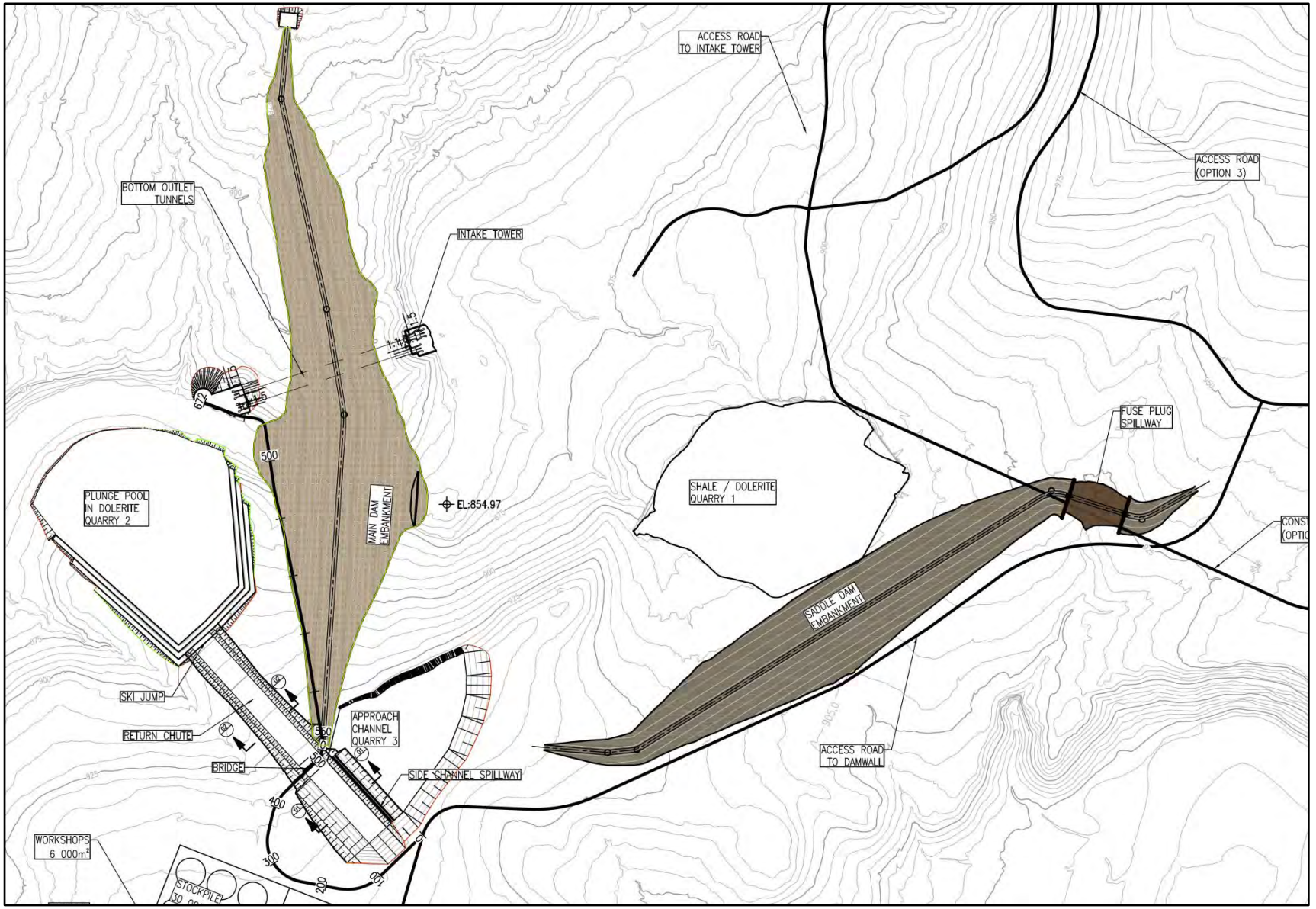


Figure 4.4: Smithfield Dam, Main Embankment, Saddle Dam and Spillway Layout

Table 4.2: Smithfield Dam Principal Data

Parameter	Description	
General		
Estimated year of completion	2025	
River	uMkhomazi River	
Nearest town	Bulwer	
Province	KwaZulu-Natal	
Dam site co-ordinates	29° 46' 30.31"S; 29° 56' 39.43"E	
Classification: Category	III	
Size class	Large	
Hazard potential	High	
Non-overspill Crest (NOC) level	RL 936 masl	
Saddle dam fuse plug spillway embankment crest level	RL 933.70 masl	
Full Supply Level (FSL)	RL 930 masl	
Minimum Operating Level (MOL)	RL 887.2 masl	
Mean Annual Runoff (MAR)	725.9 million m³/a	
Gross storage capacity at FSL	251 million m³	
Water surface area at FSL	9.53 km²	
	Main dam	**Saddle dam**
Wall height above lowest ground level (maximum height)	81 m (RL 855 masl to RL 936 masl)	26 m (RL 910 masl to RL 936 masl)
Dam type	Earth Core Rockfill Dam (ECRD)	Zoned earthfill dam
Embankment crest length	1 200 m	1 090 m
Spillway type	Side-channel	Fuse plug*
Spillway shape	Ogee	Broad crested weir
Spillway length	150 m	100 m
Freeboard for embankments	6 m	-
Freeboard for fuse plug spillway embankment	-	3.7 m
Hydrology and Floods		
Catchment area	2 058 km²	
Safety Evaluation Flood (SEF)	5 650 m³/s	
Regional Maximum Flood (RMF)	4 540 m³/s	
$Q_{1:100}$	2 389 m³/s	
$Q_{1:200}$ (RDF)	2 620 m³/s	
Outlet Works		
Dam outlet	Dual pipe system of Nominal Diameter (ND) 1.8 m; 6 intakes; butterfly and gate valves.	
Tunnel inlet	Tri pipe system of ND 2 m; 6 intakes; butterfly and gate valves.	

* *A fuse plug spillway is proposed for the saddle dam, and the DWS Dam Safety Office will consider this fuse plug spillway as part of the licence process.*

4.4 Construction Materials and Geotechnical Investigations

The geotechnical investigations for the dam are included in the Geotechnical Report for Smithfield Dam *(P WMA 11/U10/00/3312/3/2/3 – Supporting document 3: Smithfield Dam: Materials and Geotechnical Investigation)*.

4.4.1 Foundations

a) Main Embankment

The site has a low seismic risk and comprises shales (mud rocks) with subordinate sandstones and intrusions of dolerite. Three (3) near-horizontal dolerite sills have intruded mainly concordantly into the sedimentary strata and are responsible for the narrow river valley at the dam site and the presence of good quality rock for concrete aggregate and rockfill. The estimated founding levels for the shells of the rockfill embankment are as follows:

- At the upper left and right flanks a 6 to 10 m layer of colluvium and residual soil/completely weathered shale has to be removed;
- In the central river section 1.5 to 5 m of residual soil/completely weathered shale/dolerite and medium dense river alluvium has to be removed, and
- A large part of the right flank has 11.2 to 14.4 m of transported sandy clay with boulders that has to be removed.

These excavations will yield a large volume of material, which could be suitable as impervious and semi-pervious earthfill for the saddle embankment. Laboratory testing of this material will, however, need to be undertaken by the Implementing Agent to confirm the suitability thereof.

The estimated excavation depths for the clay core, which ranges between 2 m and 15 m, were based on the results at borehole positions of the geotechnical investigation that was carried out along the dam centre line and are summarised in the Engineering Feasibility Design Report (*P WMA 11/U10/00/3312/3/1 – Engineering feasibility design report: Volume 1)*. It will, however, be necessary to make provision for a grout curtain to a depth of about 66% of the water head along the centre line of the main embankment at the position of the clay core.

b) Saddle Embankment

A 0.1 to 0.5 m thick layer of organic topsoil has to be removed for the foundings of the shells to be on highly weathered shale. The clay core can be founded on moderately weathered shale at depths of between 2 and 4 m. It will be necessary

to make provision for a grout curtain to a depth of at least 20 m below Quarry I, which will be located just upstream of the saddle embankment. The estimated excavation depths for the shells and clay core are also summarised in the Engineering Feasibility Design Report (*P WMA 11/U10/00/3312/3/1 – Engineering feasibility design report: Volume 1).* More detailed foundations investigations for the saddle embankment will, however, need to be undertaken by the Implementing Agent.

c) Spillway

From the geotechnical investigations it was derived that the control structure for the proposed side-channel spillway for the main dam will most probably be founded on slightly weathered shale at estimated depths ranging between 15 and 20 m below ground surface. The concrete lined chute will be founded on moderately weathered shale at estimated depths of between 10 and 12 m.

The proposed position of the side-channel spillway structure for the main dam was not adequately drilled to determine foundation levels and therefore additional geotechnical investigations will need to be undertaken by the Implementing Agent to determine foundation conditions at the position of the main spillway. The erosion potential at the fuse plug spillway must be investigated during the detailed design phase. Based on the outcomes of the additional geotechnical investigations a total cost optimisation of the dam's freeboard and spillway widths will be required.

It is also proposed that the possible damage to the fuse plug's spill channel during an extreme flood event be investigated in more detail during the detailed design phase to ensure that the minimum potential loss of materials along the valley section.

The excavations for the clay core of the saddle embankment will be adequate for the foundation of the concrete structure for the fuse plug spillway.

4.4.2 Quarries and Borrow Areas

From the materials investigations it was deduced that sufficient materials are available for the selected dam types for Smithfield Dam's main dam and saddle dam from the recommended quarries and borrow areas, which are shown in **Figure 4.5** below.

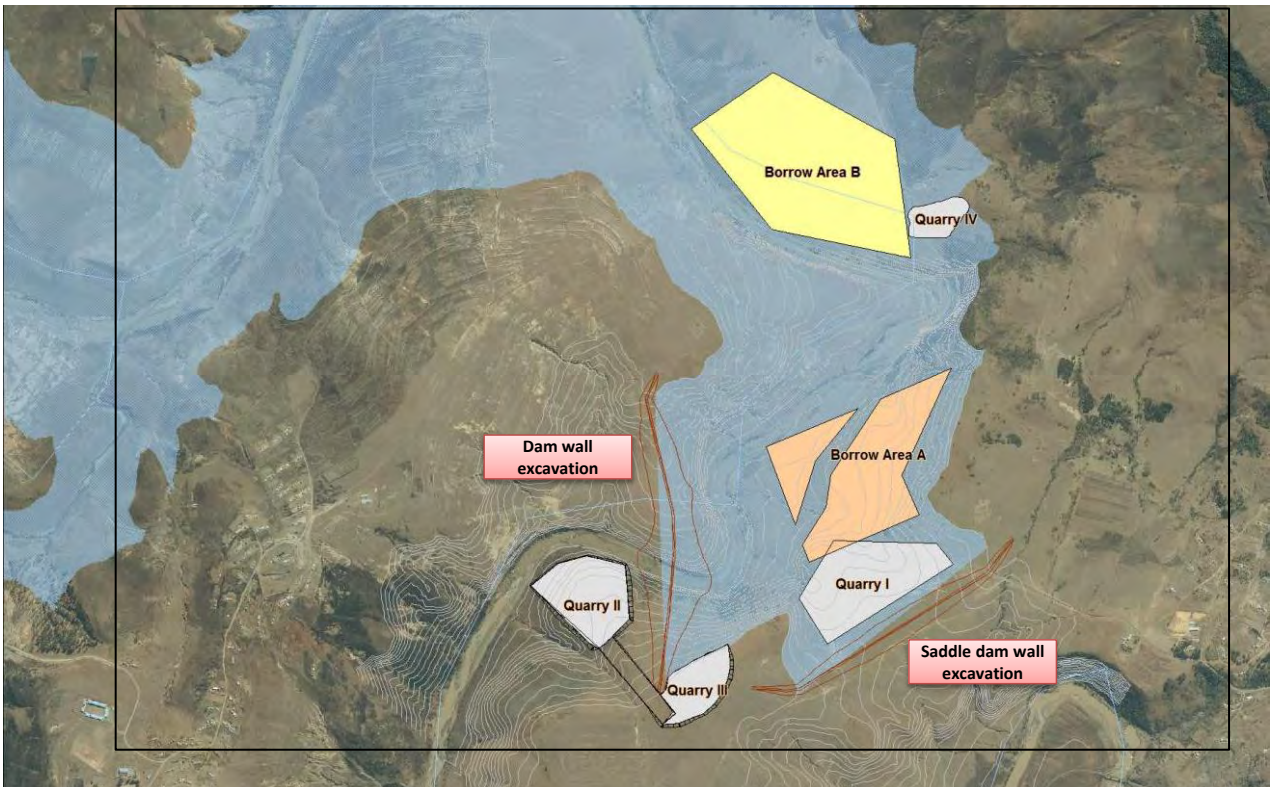


Figure 4.5: Proposed Quarry and Earthfill Borrow Areas for Smithfield Dam's Embankment Materials

The rockfill material for Smithfield Dam's main embankment needs to be obtained from the identified quarries. Earthfill material for the saddle embankment needs to be obtained from excavation for the main dam's embankment and the borrow areas. No suitable sand is available from the dam basin and it is anticipated that the sand for the filters will need to be imported from suitable commercial sources. Clayey sand from the borrow areas will be used in the core zone and highly and completely weathered material in the shell zone of the dam and will be obtained from the excavation at Quarry I. The removal of this material will be necessary to expose the dolerite to be used at other locations. It is recommended that the sand for the filters should be imported from suitable commercial sources, as for the main embankment.

The development of Quarry I could impact on the saddle dam's stability, therefore the stability of the saddle dam needs to be verified pending the size and position of Quarry I.

4.5 DESCRIPTION OF SMITHFIELD DAM

4.5.1 Embankments

Based on the site geology and the availability of construction materials the feasibility investigations recommended a zoned Earth Core Rockfill Dam (ECRD)

for the main dam, and a zoned earthfill embankment dam for the saddle dam as the most feasible dam types for the site. More detailed geotechnical investigations for the site may, however, reveal conditions that may favour other dam types for both the main dam and the saddle dam. This aspect needs to be investigated during the detailed design phase, and the onus is on the Implementing Agent to undertake a due diligence assessment to confirm the dam types for both the main dam and the saddle dam after further geotechnical investigations has been undertaken. **Figures 4.6** and **4.7** below show the various material zones for the main embankment and the saddle embankment.

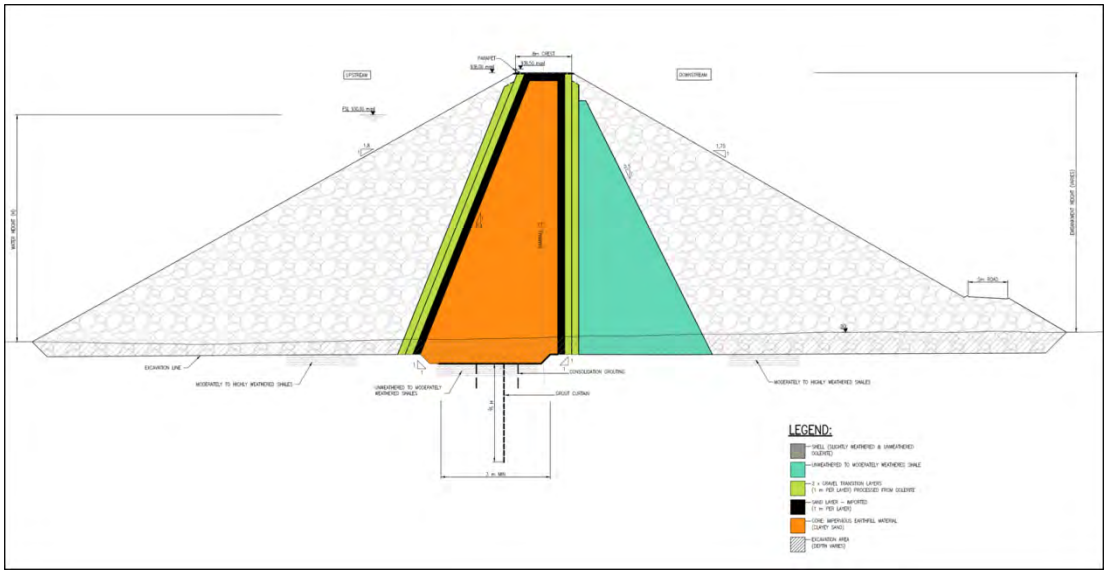


Figure 4.6: Cross Section of Smithfield Dam's Main Embankment (ECRD)

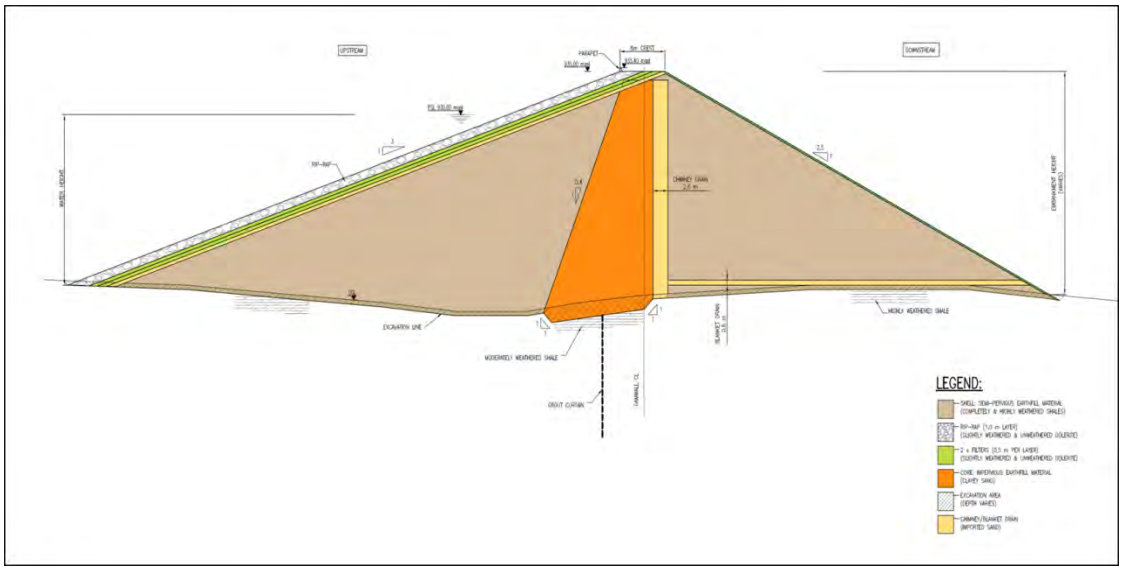


Figure 4.7: Cross Section of the Saddle Embankment at Smithfield Dam

Figure 4.8: Artistic Impression of Smithfield Dam

4.5.2 River Diversion

The river diversion must be planned to be implemented in phases related to the different seasons (high/low flow). The lower risk of flooding during the winter months (low flow season) must be considered when the construction programme is compiled. If another dam type, instead of an ECRD, is selected for the main dam then a similar approach for the river diversion will be required. In addition to this the proposed diversion tunnels will be used or form part of the outlet works (refer **Section 4.5.4** below). Details of the seven (7) proposed phases of river diversion; description of the construction of each phase and the risk of possible damages are included in the *Engineering Feasibility Design Report (P WMA 11/U10/00/3312/3/1).*

4.5.3 Spillway Configuration

A side-channel spillway with a crest length of 150 m on the left flank of the main embankment dam and a fuse plug spillway with a crest length of 100 m on the left flank of the saddle embankment dam (refer **Figure 4.4** above), are recommended to safely discharge the SEF (refer **Table 4.2** above). The side channel spillway for the main dam will consist of:

- An approach channel to be excavated to RL 926 masl;
- An ogee shaped spillway;
- A concrete lined spillway chute of 40 m wide, and

- A ski-jump discharging into a plunge pool.

The fuse plug spillway for the saddle dam will consist of:

- A concrete sill structure at the FSL of RL 930 masl, and
- Pilot channels in the fuse plug at the 1:200-year flood water level in the dam that will activate the fuse plug.

4.5.4 Outlet Works

The proposed outlet works needs to release water into the uMkhomazi River from the dam for the EWR; downstream users and for emergency drawdown conditions.

The outlet works has a circular intake tower and will be positioned on top of the intake section of the right flank river diversion tunnel. It is recommended that this diversion tunnel also serve as the permanent outlet through which water will be discharged into the uMkhomazi River.

The pipe work inside the proposed intake tower will consist of a twin, or dual system, that will consist of multi-level intakes at different levels with butterfly valves for selecting the level at which water will be drawn off, and sleeve valves for controlling the releases (refer **Table 4.2** above).

4.6 Recommendations and Directives Arising from the Feasibility Design

Recommendations/directives arising from the feasibility design for the implementation of Smithfield Dam are the following:

- A due diligence study should be undertaken by the Implementing Agent to confirm the selected dam types for the main dam and the saddle dam after further geotechnical investigations have been undertaken. If substantial new geotechnical information gives motivation for another dam type, for both the main dam and the saddle dam, then other dam types need to be well motivated and approved by the Client. This new information should be presented to the DWS CD: IWRP for discussion.
- Additional geotechnical investigations are required in the tender design phase to determine the following:

- Main Dam: The excavation for the founding level of the main embankment will yield a large volume of material, which might be suitable as impervious and semi-pervious earthfill for the saddle dam's embankment. Laboratory testing of this material should be undertaken by the Implementing Agent to confirm the suitability thereof;
- Spillway: Determine foundation conditions for the position of the main spillway and chute as well as the erosion potential at the fuse plug spillway. Subsequently a total cost optimisation of the dam in terms of freeboard and spillway lengths, for both the main dam and saddle dam, should be carried out;
- Saddle Dam: A grout curtain at the saddle embankment is recommended, which must be confirmed with additional geotechnical investigations during implementation, to a level at least 20 m below the bottom (floor) of Quarry I, due to the development of this quarry just upstream of the saddle dam's embankment;
- Quarry I: Due to the fault line and the position of the saddle dam, further geotechnical investigations should confirm the volume and quality of the available materials;

- New routes for road deviations, including Provincial Road R617: The suitability of the material for road construction to be obtained from the borrow areas and quarries for the dam must be investigated, and
- Proposed Flow Gauging Weirs: No geotechnical and/or materials investigations were undertaken for the three (3) proposed flow gauging weirs and must be undertaken by the Implementing Agent.

- The importation of sand from suitable commercials sources for the filters;
- The anchors and drainage system for the spillway chute for the main dam should be determined during the detailed design phase;
- Optimising of the chute, ski jump and plunge pool (including a hydraulic model study) during the detailed design phase;
- Four (4) intake levels for the river releases should be designed to ensure that the dam and its management has a minimal impact on the downstream aquatic life;

- Despite the small probability of a gravel failure and large rock slide from oone of the identified slopes on the rim of the reservoir a potential slide of this slope might result in large volumetric displacement and overtopping of the dam due to a high wave run-up. This slope must be investigated further during detailed design phase to ensure that overtopping of the Non Overspill Crest (NOC) will be prevented in case of such a failure event;
- The outlet works, including the intake tower, can be accessed via a bridge from the main dam embankment. This structure should be designed during the detailed design phase as such as to limit the influence of seismic activity on the integrity of the structure;
- Smithfield Dam's outlet works should be designed as such to allow for the addition of a Hydropower Plant (HPP) that can be connected to the outlet pipe system in future, and
- The detailed design for the access road should allow for an extreme flooding event downstream of the saddle dam's fuse plug spillway, when the fuse plug breach.

5 SCOPE OF WORK FOR THE PROPOSED BULK RAW WATER CONVEYANCE INFRASTRUCTURE

The proposed raw water conveyance infrastructure from Smithfield Dam on the uMkhomazi River to the Baynesfield WTP, including the proposed take-off bi-directional raw water pipeline to and from Langa Dam are shown in **Figure 5.1** below.

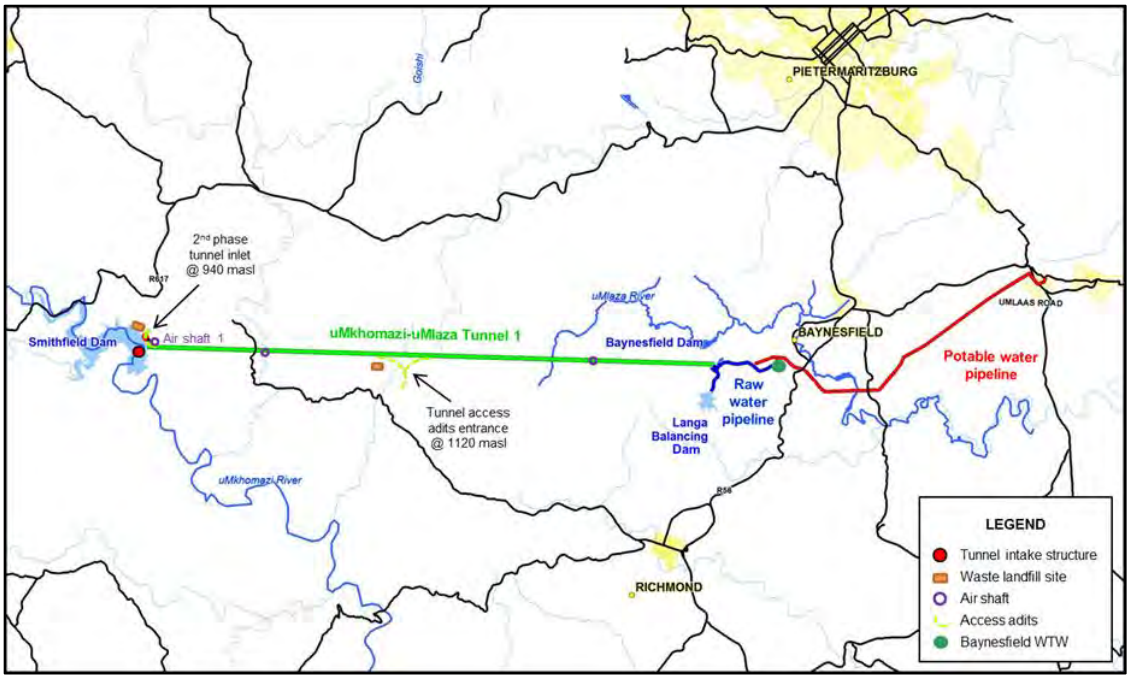


Figure 5.1: Layout of the Proposed Bulk Water Conveyance System

5.1 DESCRIPTION OF THE BULK RAW WATER CONVEYANCE INFRASTRUCTURE

a) Tunnel Intake Structure

The current position of the tunnel intake structure is located at **Latitude 29° 45' 50.56"S, Longitude 29° 57' 05.05"E** on the left flank of Smithfield Dam's main dam. The structure will house the hydro-mechanical equipment required to operate and control the releases from Smithfield Dam through the tunnel. The tunnel intake structure must also accommodate the implementation of the uMWP-2 tunnel in future.

b) Tunnel Outlet Structure and Portal

The current position of the tunnel outlet structure and portal is located at **29°46'16.42''S; 30°18'15.97''E** in an area on the Baynesfield Estate, which has

been designated as a wetland by the DEA. It will consist of a mass concrete structure with two units. The structure will accommodate the transition between the 3.5 m diameter concrete tunnel and the 2.6 m diameter steel pipeline, and the vertical change in the level of the steel pipeline. Access into the tunnel will also form part of this structure. A valve chamber will also be housed in this structure to accommodate a valve at the start of the pipeline to allow for inspection of the pipeline without having to drain the tunnel. A concrete slab assembling of the TBM during construction will also be required at this structure. After construction this slab should be decommissioned, but a short section of this slab of approximately 6 m by 30 m should, however, be retained for access to the outlet structure. The tunnel outlet portal in relation to the existing Mbangweni Dam is shown of **Figure 5.6** below. The connection between the 3.5 m diameter tunnel and the 2.6 m inside diameter raw water pipeline is described in more detail in *Section 4.6* of the *Engineering Feasibility Design Report (P WMA 11/U10/00/3312/3/1)*.

c) *uMkhomazi-Baynesfield Tunnel 1 – Phase 1*

The 32.5 km long, and 3.5 m inside diameter, transfer tunnel will be a gravity conveyance system and extends from the east side of Smithfield Dam's reservoir to the upper reaches of the existing Mbangweni Dam in the uMlaza River Valley. Ventilation shafts are provided to accommodate air flow in the tunnel. Vehicle access must be provided at mid-length of the tunnel and at its outlet in the uMlaza River Valley.

During the EIA Process the current proposed tunnel alignment was opposed by some of the Interested and Affected Parties (I&APs). Further investigations are currently underway to assess the impacts of the tunnel construction in terms of noise and vibration on the active nests of the critically endangered Blue Swallow during their breeding season. Alternative tunnel alignment investigations are also currently underway, and if the tunnel alignment is changed then the alignment of the proposed 5.12 km long raw water pressure pipeline (refer ***(d)*** below) will also need to be revised.

d) *Proposed Bulk Raw Water Pipelines*

The proposed bulk raw water pipelines will consist of the following two (2) pipelines:

- An approximately 5.12 km long 2.6 m inside diameter raw water pressure pipeline needs to be connected from the tunnel outlet to the Baynesfield WTP, and

- An approximately 1.25 km long 1.6 m inside diameter take-off bi-directional pipeline along the 2.6 m diameter pipeline to convey water to and from Langa Dam).

During the maintenance periods of the tunnel, raw water will be conveyed via the afore-mentioned 1.6 m diameter pipeline to the 2.6 m diameter pipeline to the supply raw water to the Baynesfield WTP during these maintenance periods of the tunnel.

5.2 DESIGN PHILOSOPHY

The transfer capacities of the tunnels are as follows:

- uMWP-1 – Tunnel 1: The maximum transfer capacity of 8.65 m³/s will be conveyed through the uMkhomazi – uMlaza (Tunnel 1), and
- uMWP-2 – Tunnels 1 and 2: The total maximum transfer capacity of 14.86 m³/s that could be conveyed in future (beyond 2040), when the upstream Impendle Dam and second transfer tunnel (Tunnel 2) is implemented.

The hydraulic design for the bulk raw water conveyance system includes the following, which are, however, subject to optimisation during the detailed design phase:

- The 32.5 km long 3.5 m inside diameter lined uMkhomazi – uMlaza Tunnel 1;
- The Minimum Operating Level (MOL) of Smithfield Dam of RL 887.2 masl, which is the minimum water level upstream of the tunnel intake structure (intake tower). If water is abstracted from one of the bottom intakes, the friction and secondary losses incurred upstream of the tunnel intake structure were calculated as 15.2 m. The intake centre level of the lowest pipe at the tunnel intake structure will be at RL 881.5 masl. If the final design configuration of the intake tower is changed significantly during the detailed design phase, then this system should be optimised accordingly;
- Three (3) ventilations shafts are provided to accommodate air flow into the tunnel;

- The 5.12 km, 2.6 m inside diameter, long raw water pipeline from the tunnel outlet to the Baynesfield WTP;
- A stilling basin at the end of the 2.6 m inside diameter raw water pipeline at the Baynesfield WTP with a minimum water head at RL 872 masl. The Baynesfield WTP will be at this level to ensure that water will be provided under gravitation to the proposed Umlaas Road Pipeline (potable water pipeline), and
- The 1.6 m inside diameter and 1.25 km long bi-directional take-off pipeline to and from Langa Dam.

5.3 Layout of the Bulk Raw Water Conveyance Infrastructure

5.3.1 Tunnel Intake Structure

The tunnel intake structure houses the hydro-mechanical equipment required to operate and control the releases from Smithfield Dam through the tunnel. From the tunnel intake structure the raw water will be conveyed through a 1.8 m diameter pipe into the tunnel. The tunnel intake structure will also provide for the releases associated with the implementation of the uMWP-2 (upstream Impendle Dam and Tunnel 2). Therefore the tunnel intake structure will consist of three (3) intake systems. Systems 1 and 2 will be operational with the implementation of the uMWP-1 (a dual system will be required for maintenance purposes).

Although System 3 will, however, only be required for the uMWP-2, this intake must be constructed during the construction of the uMWP-1 and flanged off until the operation of this system will be necessary. The following components of System 3 must, however, be constructed during the construction of the uMWP-1:

- The bell mouth intakes at the various levels;
- The section of pipe leading from the tunnel intake structure to the second tunnel (Tunnel 2);
- The bell mouth outlet at the pipe-tunnel connection, and
- The ventilation shaft leading from the tunnel intake structure.

Each intake system will consist of multi-level bell mouth pipes with butterfly valves for selecting the level at which water will be drawn off. Control valves are situated downstream of each intake system conduit before connecting to the tunnel collector manifold for controlling the releases to the tunnel/s. Service valves (butterfly valves) are positioned in the tunnel collector manifold on both sides of each intake system's connection to allow for maintenance and

inspection, as well as to close off the intake system/s when not operational. The sectional and plan views of the tunnel intake structure are shown in **Figure 5.2** below.

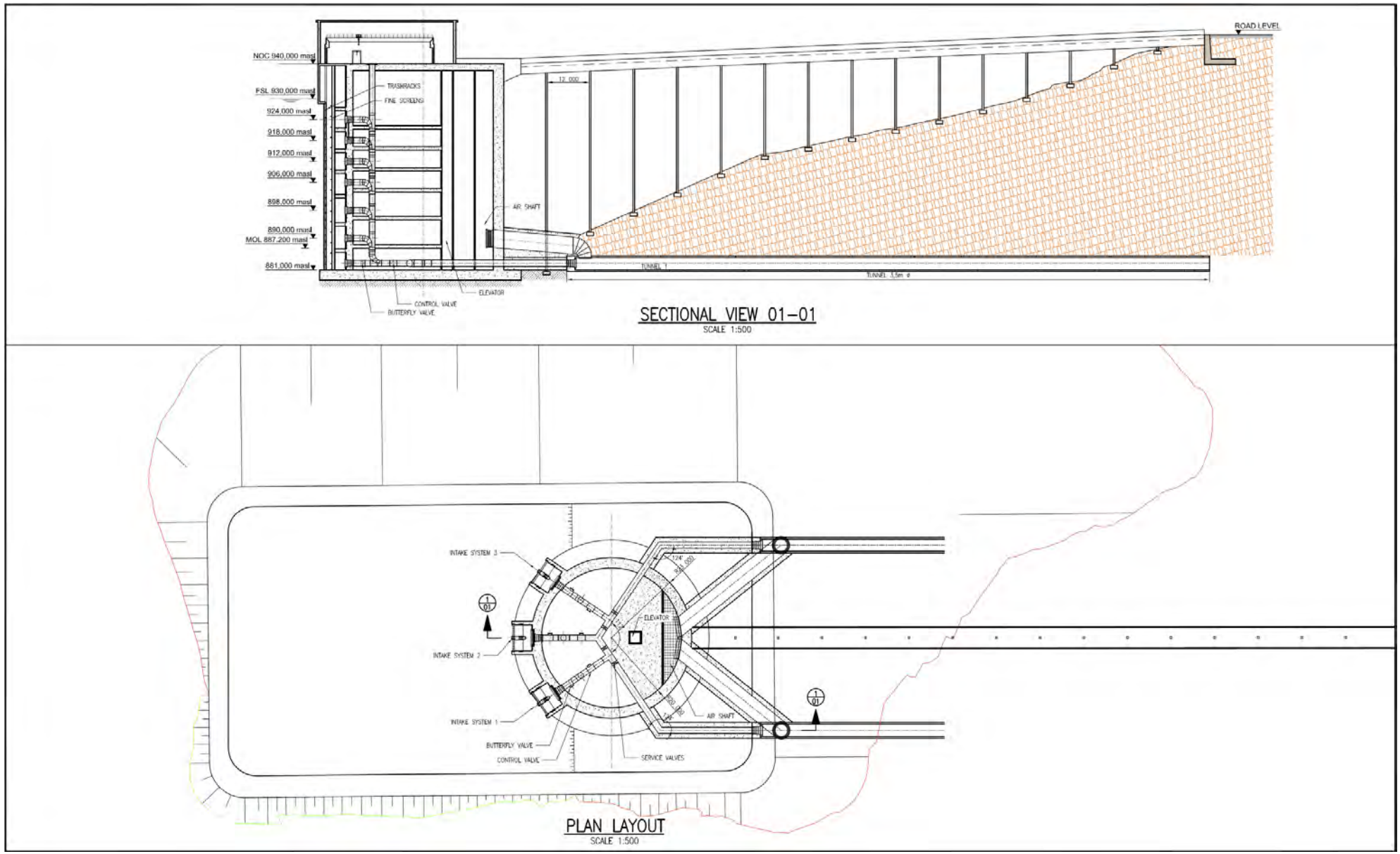


Figure 5.2: Section and Layout of the Proposed Tunnel Intake Structure at the Proposed Smithfield Dam

Six (6) abstraction levels were designed to ensure the best possible water quality will be abstracted from the dam, as described in the *Engineering Feasibility Design Report (P WMA 11/U10/00/3312/3/1)*.

A detail sediment deposition study considered the impact of sedimentation around the reservoir intake area of the tunnel inlet structure over a period of more than 100 years. This was undertaken in order to confirm the vertical alignment of the tunnel for the detailed design. The long-term reservoir sedimentation simulations indicated possible sediment deposition at the diversion tunnel intake in if the upstream Impendle Dam is not implemented (uMWP-2). After 50 years of operation the current and possible high future sediment yield indicated that the depths of the deposited sediment at the tunnel intake structure could be 0.4 m and 12.8 m respectively. If the high future sediment yield is considered over a 100 year period the depths of the deposited sediment could be 28.5 m at the tunnel intake structure and 58.5 m at the dam wall. This study therefore recommended engineering measures in the dam at the tunnel intake structure, such as a concrete wall to prevent delta sediment sliding/slumping into the tunnel intake structure and a sediment flushing tunnel for pressure flushing of the intake zone. The recommended engineering measures, and sediment flushing requirement that need to be provided must, however, be investigated and implemented by the Implementing Agent. The results of the sedimentation deposition study are concluded in the *Sediment Deposition and Impact Report (P WMA 11/U10/00/3312/2/3/2)*.

5.3.2 Tunnel 1

The layout of Tunnel 1, shown in **Figure 5.3** below, is based on the following:

- A constant downward slope of 0.027%;
- Drill and Blast Technique (DBT) excavations at both the inlet and outlet portals of the tunnel, however, care must be taken to avoid any tunnelling during the breading season of the critically endangered Blue Swallow in the area;
- A DBT access adit at the central part of the tunnel from chainage 14 750 m to 16 250 m;
- Two (2) Tunnel Boring Machine (TBM) drives, both drilling up-slope in a westerly direction from the outlet portal to the central access adit, and also in a westerly direction from the central access adit towards the inlet portal, respectively;

- Two ventilation shafts with a shotcrete lining and a access adit in the centre of the tunnel (refer **Figure 5.4** below);
- One ventilation shaft with a concrete lining near the entrance to the tunnel for the uMWP-1;
- Two tunnel waste disposal landfill sites (refer to **Section 7.1.6** below) and the use of tunnel spoil material in the embankment of Langa Dam;
- An access adit at the entrance to facilitate access to the tunnel for the uMWP-2 (Tunnel 2), and
- Construction of the first 100 m of the Tunnel 2 to ensure access when the Smithfield Dam will be at, or above, its FSL of RL 930 masl.

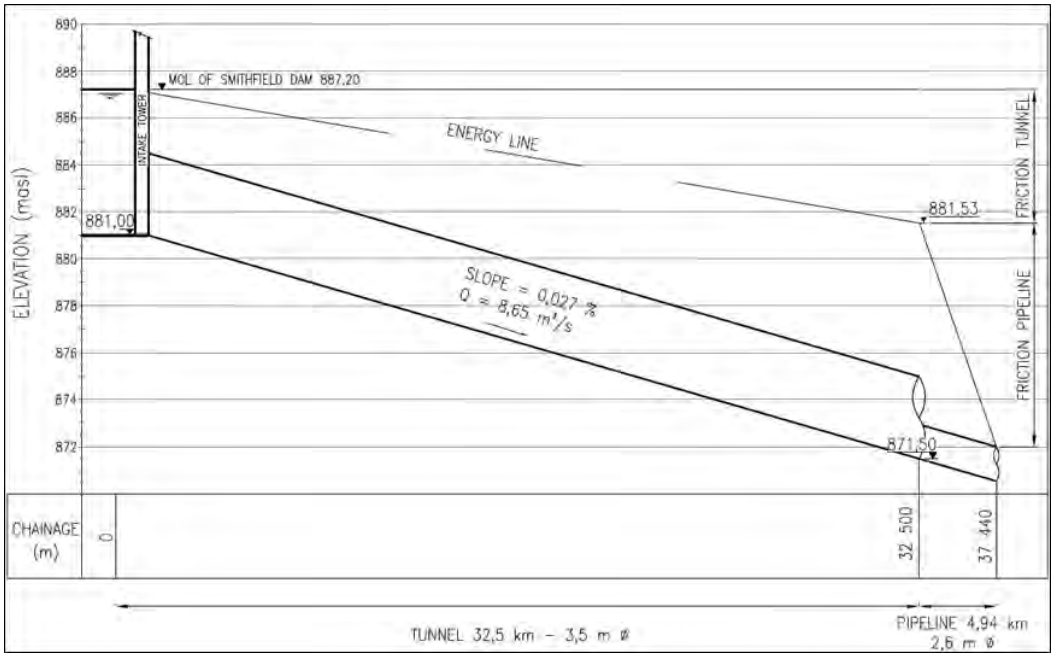


Figure 5.3: Schematic Layout of the Raw Water Conveyance System showing the Energy Line

The inlet portal; ventilation shafts; access adits and tunnel outlet should be excavated using DBT. The ventilation shafts need to be positioned between the tunnel inlet and the access adits, as well as between the access adits and the tunnel outlet, respectively. The selected recommended layout of the tunnel is shown in **Figure** 5.4 below.

Optimisation of the tunnel construction process may be required in order to fast-track the Project and must be undertaken by the Implementing Agent. Furthermore, the Implementing Agent must also take cognisance of the fact that the tunnel alignment might need to be changed in order to prevent, or minimise, the impacts of tunnel construction on the Blue Swallows, for which investigations are currently underway.

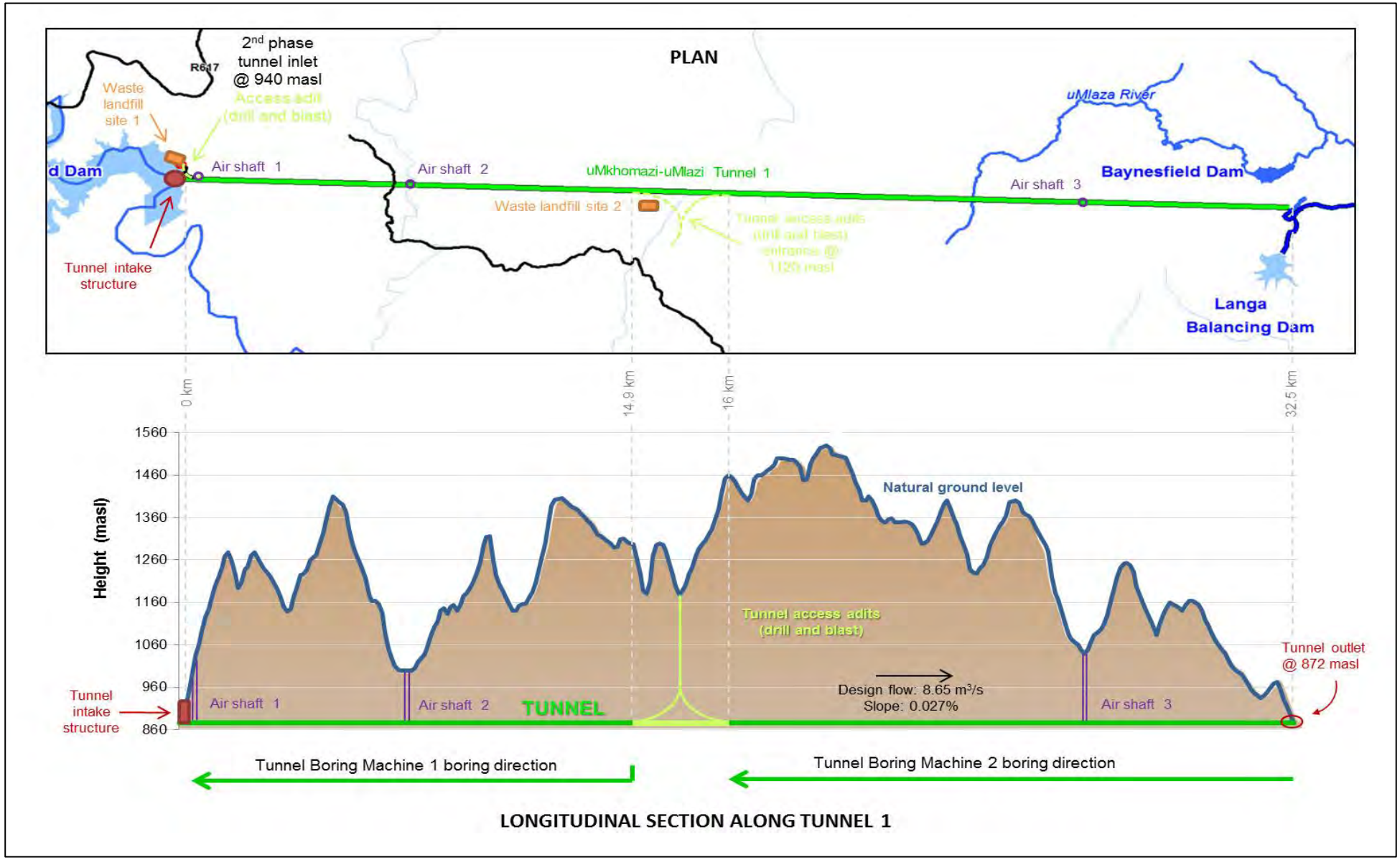


Figure 5.4: Tunnel Route and Longitudinal Tunnel Section along Tunnel 1

5.3.3 Raw Water Pipelines

The 5.12 km 2.6 m inside diameter long raw water pressure pipeline will connect the tunnel outlet to the Baynesfield WTP. A 1.25 km long 1.6 m inside diameter bi-directional take-off pipeline will convey raw water to Langa Dam from Smithfield Dam and from Langa Dam to the Baynesfield WTP during the maintenance periods of the tunnel (refer to the *Engineering Feasibility Design Report (P WMA 11/U10/00/3312/3/1)*).

The ***Baynesfield WTP, which is shown in* Figure 5.5 *below has been selected for the layout of the pipeline***. An alternative to the Baynesfield WTP Site (refer to UW's *uMkhomazi Water Project Module 3 – Potable Water Module: Detailed Feasibility Study*) will, however, change the alignment of the raw water pipeline from the tunnel outlet to the WTP. The Implementing Agent will be informed of the final location of the WTP by Umgeni Water. The Implementing Agent must also take cognisance of the fact the alignment of the raw water pipeline will also need to be revised, if the tunnel alignment is changed.

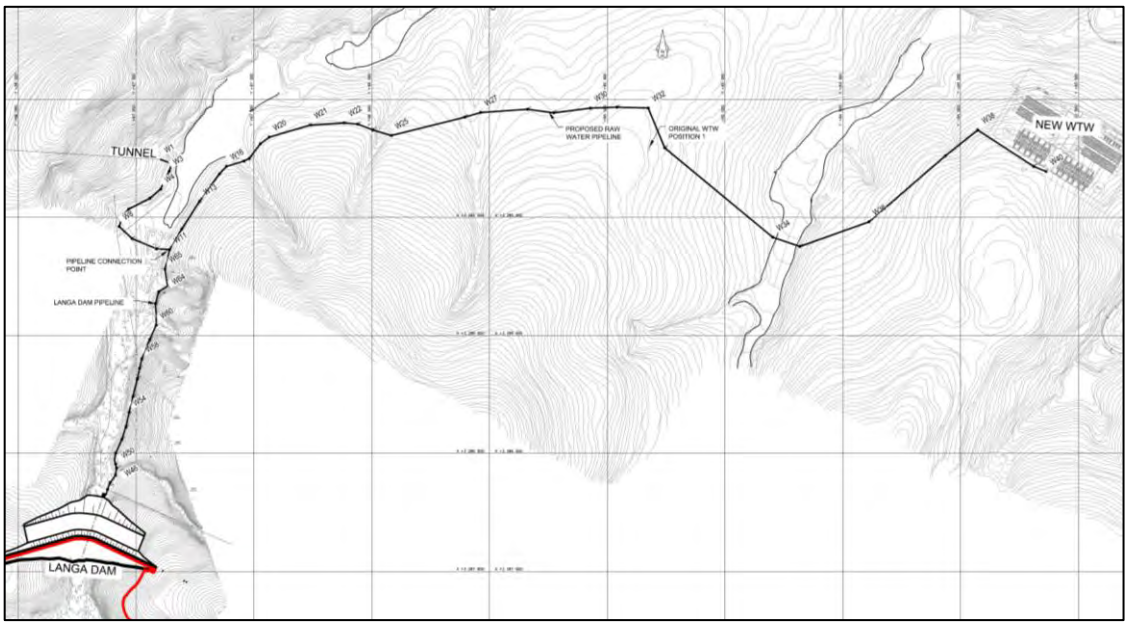


Figure 5.5: Routes of the Proposed Raw Water Pipelines

5.4 Geotechnical Investigations and Construction Materials

The geotechnical conditions for the tunnel and related infrastructure are described in detail in *Conveyance system: Material and geotechnical investigation Report (P WMA 11/U10/00/3312/3/2/5)*.

5.4.1 Tunnel Intake Structure, Inlet and Outlet Portals

The weathered rock in the area around the tunnel intake structure (intake tower) and the tunnel inlet portal was found at a depth of approximately 5 m below the ground level with less weathered and fractured rock at 15 to 20 m depth below ground level. However, in some areas slightly fractured to moderately weathered shale rock is encountered at approximately 6 m below ground level.

The water table in the area is close to the ground surface with seepage evident in some places. Therefore, all excavations will need to be adequately supported, or excavation slopes will need to be flattened, and dewatering measures will need to be put in place to facilitate both earth and concrete works.

Seepage might take place within the perimeter of the tunnel outlet portal position. If the position of the tunnel outlet portal stays the same then any earthworks, or concrete works, will be subjected to strict environmental guidelines. Appropriate measures will therefore be required, and will have to be implemented, to prevent the offset of any environmental triggers during construction. All excavations will need to be adequately supported, or flattened, and dewatering measures will be required to facilitate both the earth and concrete works.

Further geotechnical tests will have to be undertaken by the Implementing Agent to confirm whether excavated material from the tunnel inlet portal is suitable for use in either Smithfield Dam's main dam and/or the saddle dam. The Implementing Agent must undertake these tests.

5.4.2 Tunnel

Primarily fractured hard to extremely hard rock shale was encountered with some hard to extremely hard dolerite. Joints in the shale rock are mostly smooth, whilst joints in the dolerite rock are mostly rough. It is anticipated that extensive lengths of the tunnel will be excavated in either shale or dolerite and therefore it would be reasonably easy to stockpile these two types of spoil materials separately.

Significant groundwater inflows should be expected, since inter-granular and fractured aquifers may be encountered. The groundwater inflow into the tunnel during construction may require treatment because of its fluoride concentrations and to adhere to the EIA requirements, furthermore mitigation measures must also be addressed in the method statement for construction. A Water User Licence Application (WULA) will need to be submitted by the Implementing Agent

to the DWS to treat groundwater and to mitigate the impacts of groundwater during the construction of the tunnel.

It is recommended that rock material be excavated by means of a TBM. The excavated un-weathered dolerite from the tunnel excavations may be utilised in a rockfill. Alternatively, the un-weathered dolerite may be crushed and utilised as aggregate.

The un-weathered shale may be utilised as general fill, but care will have to be taken with regards to the flaky nature of the aggregate should this material be utilised as aggregate. This material, especially the carbonaceous shale, is also likely to weather in time, especially if it is subjected to wetting and drying cycles.

Figure 5.6: Artistic Impression of the Tunnel Outlet Structure and Portal

5.4.3 Raw Water Pipeline to the Baynesfield WTP

The areas to be traversed by the 2.6 m diameter raw water pipeline are mainly underlain by firm to stiff silty clay, or clayey silt containing sand; gravel; cobbles and/or boulders if current configuration is accepted. The excavated in-situ material will be suitable for use as selected layers for pavement construction and as general backfill. This in-situ material will also be marginally suitable as bedding material for the pipeline. If the excavated in-situ material is unsuitable, or insufficient, then appropriate bedding material will have to be imported from commercial sources. The western section of the pipeline traverses a stream and

a recognisable wetland, therefore unstable sidewall conditions are envisaged during the trench excavations in this area.

5.4.4 Take-off Bi-directional Raw Water Pipeline to and from the Langa Dam

No geotechnical investigations were undertaken along the route for the 1.6 m diameter take-off bi-directional raw water pipeline to and from Langa Dam.

5.5 Recommendations and Directives Arising from the Feasibility Study

Recommendations/directives arising from the feasibility design for the implementation of the bulk raw water conveyance infrastructure are the following:

- Engineering measures in Smithfield Dam to prevent delta sediment sliding/slumping into the tunnel intake structure must be investigated and implemented by the Implementing Agent;
- The tunnel intake structure shall be designed as such to accommodate both phases of the uMWP;
- Sprayed concrete (shotcrete) layers should be applied as protection to portions of the exposed excavated rock faces at the inlet and outlet portals of the tunnel, as well as at the intermediate access portal and in the ventilation shafts. This should, however, be confirmed with more detailed geotechnical investigations during the detailed design phase;
- Both the tunnel inlet and outlet portals should be excavated in a step formation at a slope of 1V:1.5H;
- Further geotechnical investigations must be undertaken by the Implementing Agent for the tunnel to assess the tunnel conditions and the need for lining as well as estimates of the expected sources of groundwater.
- The groundwater conditions and groundwater quality aspects must also be identified and assessed by the Implementing Agent;
- The disposal of the groundwater should be mitigated according to the conditions that will be set by the EA and the required Water Use Licence to be obtained by the Implementing Agent;
- The basic assessment of surge in all the raw water conveyance infrastructure that was undertaken during the feasibility design should be taken forward during the detailed design phase;
- Detail analysis of the 2.6 m and 1.6 m diameter raw water pipelines should be done during the detailed design phase in order to assess the surge

pressures, pipe wall thicknesses, the positioning of valves and scours, as well as river and stream crossings;

- A hydraulic jump type stilling basin is proposed at the end of the 2.6 m diameter raw water pipeline at the Baynesfield WTP, but USBR Type II and USBR Type III stilling basins should also be investigated during the detailed design phase;
- At the end of the 2.6 m diameter raw water pipeline provision must be made to allow for the addition of a HPP that can be connected to the pipe at the Baynesfield WTP in future, and
- Any unpermitted waste must be transported to, and disposed of, at legal/registered commercial landfills.

6 SCOPE OF WORK FOR LANGA DAM

6.1 LOCATION OF LANGA DAM

Langa Dam will be situated on the Mbangweni River, which is a small tributary of the uMlaza River, about 1.7 km south of the proposed site for the tunnel outlet portal and about 9.8 km slightly north-east of Richmond on the farm Nooitgedacht 903, also known as the Baynesfield Estate. The Baynesfield Estate is a diversified commercial farming operation which is operated by the company, Joseph Baynes Estate (Pty) Ltd. The Implementing Agent must, however, also take cognisance of the fact that the Langa Dam option, and/or the position of this dam, might also change.

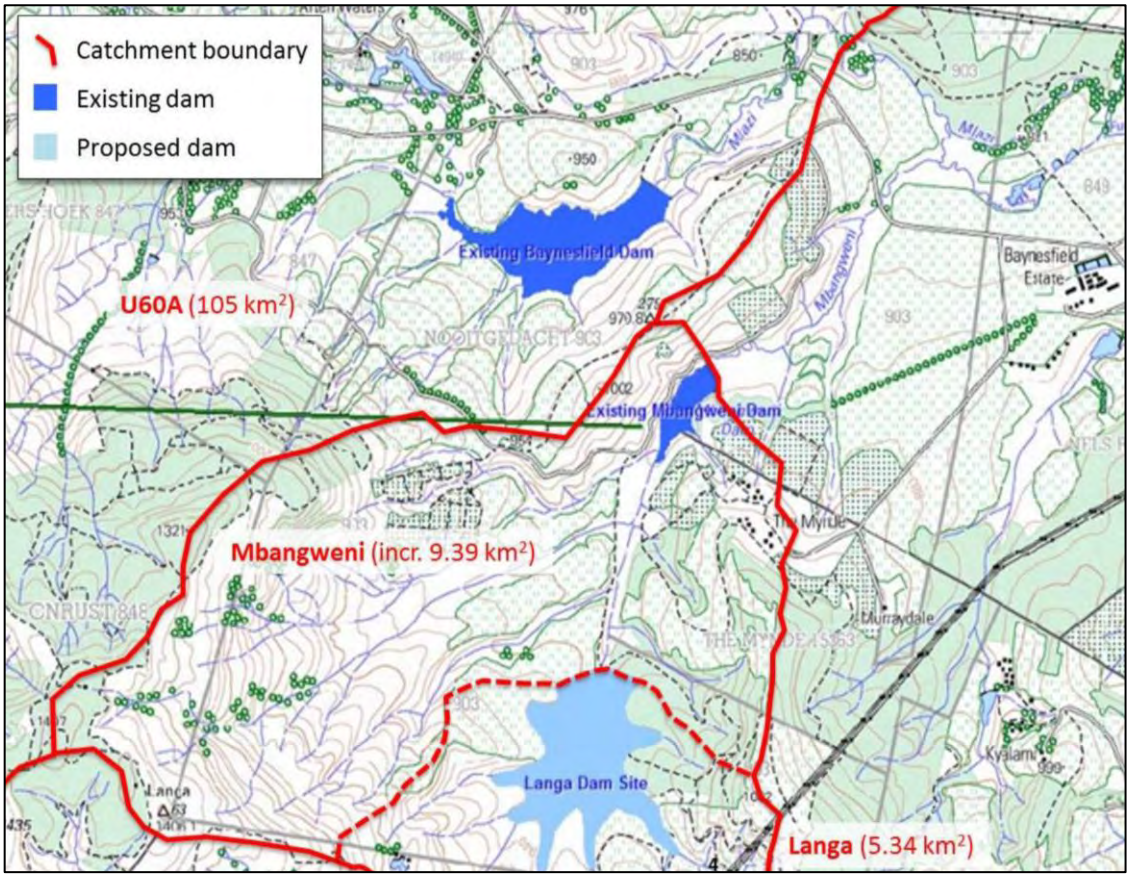


Figure 6.1: Location of Langa Dam

The coordinates of the point where the centreline of the dam intersects the river are: **Latitude: 29° 47' 17.75"S, Longitude: 30° 18' 01.80"E**.

6.1.1 Water Resource Detail

Langa Dam will be required to store water for the supply of raw water to the Baynesfield WTP during maintenance periods of the tunnel and during

emergencies, when raw water cannot be supplied directly from Smithfield Dam via the tunnel to the Baynesfield WTP. The dam was sized for the maximum possible storage to provide two months of supply together with the resources of the integrated Mgeni WSS. The yield at 99% annual assurance level of Smithfield Dam is 215 million m³/a (2040 development level), after full provision has been made for releases to support the EWR. The live storage of Langa Dam is 14.82 million m^3, and therefore the dam can supply the Baynesfield WTP for a period of only 25 days at 99% assurance of supply. The FSL of Langa Dam cannot be higher than RL 923.00 masl, since it will then not be possible to provide water to the dam under gravity from Smithfield Dam.

6.1.2 Sedimentation

Based on the Sedimentation Study (*Sediment Yield Report* (*Supporting Document 1: Water Resources Yield Assessment*)), a sediment yield of 1 165 t/km^2/a has been estimated for Langa Dam. The volume of sediment that will be accumulated in the dam basin after 50 years is estimated to be approximately 0.21 million m³. No sediment deposition study was undertaken for Langa Dam to assess the impact of sedimentation around the reservoir intake area of the proposed outlet works (refer **Section 6.4.3** below). It was also not assessed whether any engineering measures would be required in the dam to prevent any delta sediment sliding/slumping into the outlet works, and whether sediment flushing of the intake zone will be required. An assessment of the sediment deposition in the dam must therefore be undertaken by the Implementing Agent to confirm the dam's MOL (RL 898.24 masl.

6.1.3 Flood Hydrology

a) Spillway Design Floods

Langa Dam will be a large dam (wall height >30 m) with a high hazard potential (due to extensive downstream developments) and will be classified as a **Category III** dam in terms of the standing Dam Safety Regulations.

The following inflow flood peaks were selected to size the spillway, also considering possible operational flows with regard to the RDF:

- RDF - 1:200 year RI 204 m³/s
  - plus 8.65 m^3/s from the take-off pipeline: 212.65 m³/s
- SEF = RMF+Δ 313 m³/s
  - plus 8.65 m^3/s from the take-off pipeline: 321.65 m³/s

Initially it was found that Langa Dam would not require a spillway, and that any excess water above the FSL could be drawn from the dam via the proposed combined inlet and outlet system if needed (refer **Section 6.4.3** below). If the SEF inflow hydrograph, with an estimated total volume of 0.676 million m³, should flow into the dam when the dam is at its FSL of RL 923 masl then the maximum water level in the dam will be approximately RL 923.704 masl if the dam does not have a spillway. It was, however, recognised that there is the risk that operational flaws could occur and that the total release from Smithfield Dam of 8.65 m³/s could be conveyed to Langa Dam, via the 1.6 m diameter bi-directional take-off pipeline. As a precautionary measure provision was therefor made for a small 10 m wide spillway, for which the design discharge is 8.65 m³/s. The spillway design and the need for a spillway must, however, be investigated in more detail during the detailed design phase.

b) River Diversion Design Floods

The appropriateness of the proposed selected flood diversion criteria should be reviewed during the detailed design phase, and must be approved by the DWS as well as by the Approved Professional Person (APP) for the dams (Smithfield and Langa dams).

6.1.4 Proposed Operating Rules for the Dam

During the implementation phase of the uMWP-1 detailed operating rules will be defined; optimised and established for Langa Dam by the Operating Entity. Langa Dam must, however, be filled; topped up and kept full from Smithfield Dam, preferably when the latter dam will be spilling or during off-peak periods. The EWR and the current water requirements from the downstream existing Mbangweni Dam will, however, have to be released from Langa Dam.

6.2 WATER SUPPLY FROM LANGA DAM

6.2.1 Ecological Reserve

The operating rules for the EWR releases will be informed by the outcomes of the *Classification of Water Resources and Determination of the Comprehensive Reserve and Resources Quality Objectives in the Mvoti to UMzimkhulu Water Management Area (DWA, 2015/16)* ***and must be established by the Operating Entity in accordance with the statutory requirements, and according to the developed EWR Rule Table.*** The TECs and EWR in the Mvoti

to UMzimkhulu Water Management Area were also gazetted in Government Gazette No. 40075 dated 17 June 2016.

6.2.2 Permanent Water Supply Infrastructure at Langa Dam

There will be no direct water uses from Langa Dam, other than supply to the Baynesfield WTP. It is therefore not foreseen that any other permanent water supply infrastructure will be required at the dam, apart from the outlet structure to release the EWR and the current water requirements for the downstream uses from the existing Mbangweni Dam.

The Baynesfield Estate, however, requested whether Langa Dam can be used for recreational purposes. The viability of this should, however, be confirmed by the EIA.

6.2.3 Existing Water Entitlements in the Dam Basin and Downstream Water Use

There are no existing entitlements in the dam basin, other than what is required to sustain the current yield of the existing downstream Mbangweni Dam.

6.2.4 Dam Characteristics

The stage-storage volumes and surface area relationships from the available contour map for Langa Dam's basin are shown in **Figure 6.2** below.

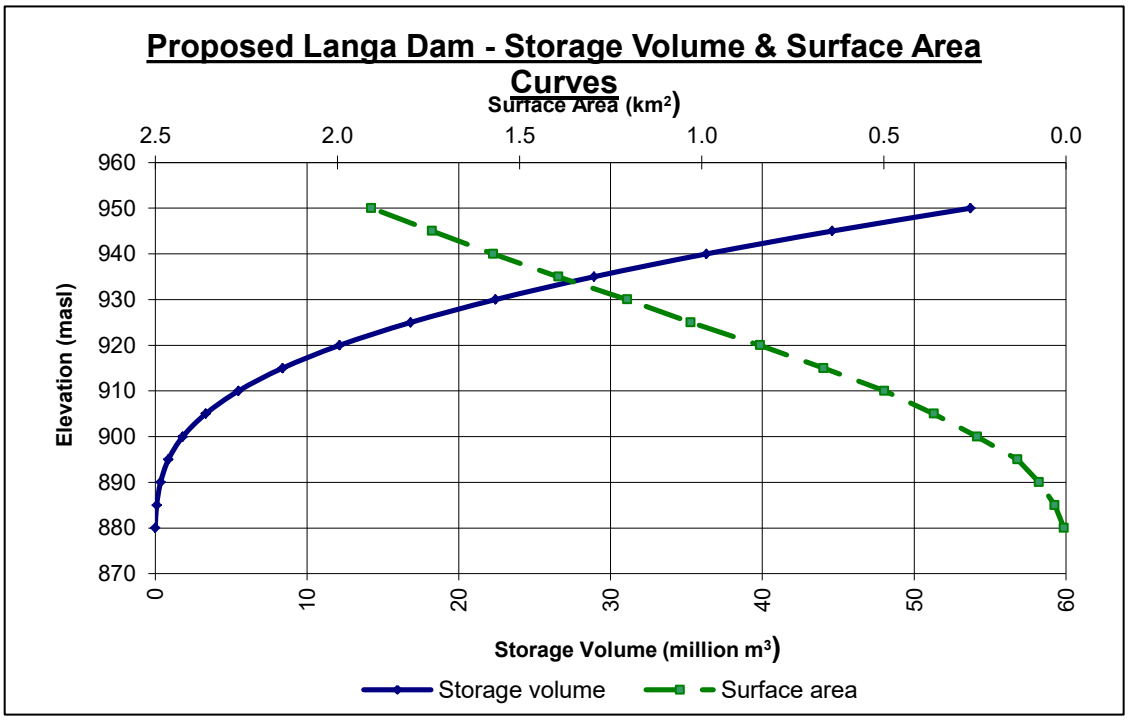


Figure 6.2: Storage Volume and Surface Area Curves for Langa Dam

The layout of, and principal data for, Langa Dam is shown on **Figure 6.3** and summarised in **Table 6.1** below.

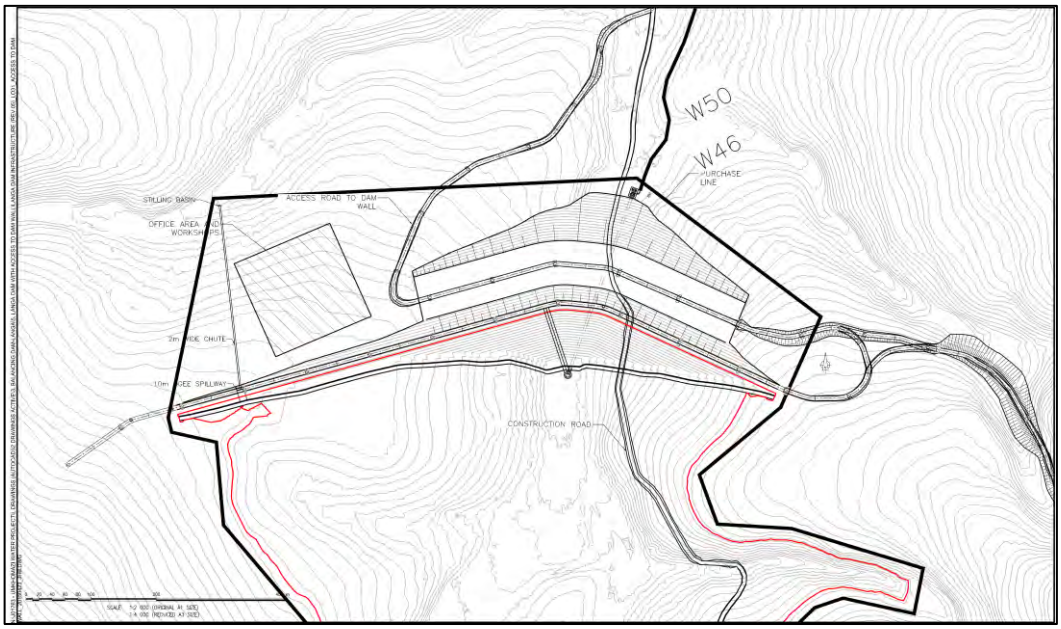


Figure 6.3: Langa Dam, Main Embankment and Spillway Layout

Table 6.1: Langa Dam Principal Data

Parameter	Description
Estimated year of completion	2025
River	Mbangweni River
Nearest towns	Pietermaritzburg & Richmond
Province	KwaZulu-Natal
Dam site co-ordinates	29° 47' 17.75"S, 30° 18' 01.80"E
Classification: Category	III
Size class	Large
Hazard potential	High
Dam type	Concrete Faced Rockfill Dam (CFRD)
Catchment area	5.34 km²
Recommended Design Flood (RDF)	1:200 year
Design discharge for the spillway	**8.65 m^3/s*
Peak inflow of the 1:200 year flood	212.65 m³/s
Regional Maximum Flood (RMF)	283 m³/s
Safety Evaluation Flood (SEF)	321.65 m³/s
Full Supply Level (FSL)	RL 923.00 masl
Approximate river bed level	RL 880.00 masl
Minimum Operating Level (MOL)	RL 898.24 masl
Non Overspill Crest (NOC) level	RL 926.60 masl
Gross storage volume (incl. storage created by the quarry)	15.67 million m³

Parameter	Description
Live storage volume (incl. storage created by the quarry)	14.82 million m³
Water surface area at FSL	95.48 ha
Spillway type	Side-channel
Spillway shape	Ogee
Spillway length	10 m
Freeboard	3.6 m
Estimated sediment volume after 50 years	0.21 million m³
Mean Annual Runoff (MAR)	2.03 million m³/a
Maximum wall height of the embankment	46.60 m
Maximum wall width of the embankment	202.72 m

* *Refer to **Section 6.1.3** above for discussion on why the design discharge is 8.65 m^3/s for the spillway.*

6.3 Construction Materials and Geotechnical Investigations

6.3.1 Foundation

The area around the proposed dam site is underlain by rocks of the Pietermaritzburg Formation of the Ecca Group, comprising shales and siltstones with subordinate sandstones. One near-horizontal dolerite sill had intruded concordantly into the sedimentary strata. For the shells of the proposed rockfill embankment, between 1.6 m and 5.3 m of colluvium and residual soil/completely weathered shale need to be removed along most parts of the centre line. However, in an area on the right flank, weak completely weathered shale and dolerite extends to a depth in excess of 17 m and will need to be removed. It is recommended that provision be made for a grout curtain to a depth of about 66% of the water head along the centre line.

6.3.2 Quarry Material

The estimated available volume of un-weathered shale and dolerite from the proposed quarry in the dam basin is 1.2 million m^3. From this available volume of un-weathered shale and dolerite about 620 000 m^3 will be used in the rockfill embankment of the dam.

6.3.3 Embankment Material

The rockfill embankment will consist of un-weathered shale and dolerite of which about 620 000 m^3 and 250 000 m^3 will be sourced from the quarry in the dam basin below the FSL and tunnel spoil respectively. A berm will also be created downstream that will form part of the embankment. The purpose of this berm will be to accommodate the estimated 563 000 m^3 spoil from the tunnel outlet portal and dam excavations.

6.4 DESCRIPTION OF LANGA DAM

6.4.1 Embankment

Based on the site geology and the availability of construction materials the feasibility investigations recommended a Concrete Face Rockfill Dam (CFRD) as the most feasible dam type for the site. More detailed geotechnical investigations for the site may, however, reveal conditions that may favour another dam type. This aspect needs to be investigated during the detailed design phase. The onus is, however, on the Implementing Agent to undertake a due diligence assessment to confirm the dam type after further geotechnical investigations have been undertaken.

The NOC will be at RL 926.60 masl with a crest width of 7 m and the estimated total length of the dam wall will be 573 m. The upstream and downstream slopes of the rockfill embankment will be 1V:2H and 1V:2.2H respectively. Dolerite is the preferred option for downstream protection, however, to comply with the EA alternatives (e.g. a vegetated downstream slope) may have to be considered. The various material zones for the proposed CFRD embankment with dolerite downstream protection layer are shown on **Figure 6.4** below. Artistic impressions of the proposed dam wall with dolerite and vegetated downstream protection layers are shown on **Figure 6.5** and **Figure 6.6** below. The final embankment cover should, however, be confirmed during the EIA Process and the Implementing Agent will be informed accordingly.

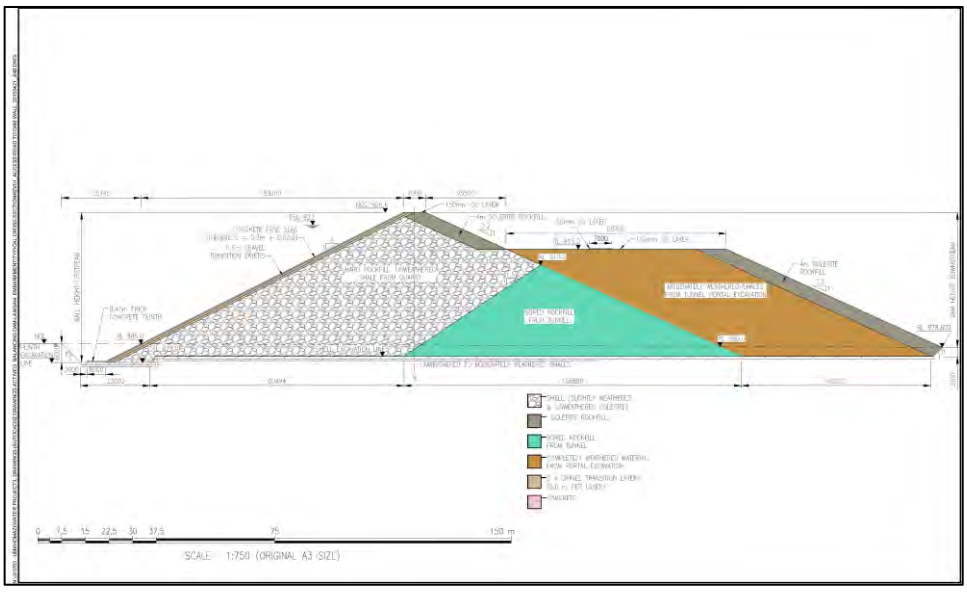


Figure 6.4: Cross Section of the CFRD Embankment at Langa Dam with a Dolerite Downstream Protection Layer Dam

Figure 6.5: Artistic Impression of Langa Dam with a Dolerite Downstream Protection Layer

Figure 6.6: Artistic Impression of Langa Dam with a Vegetated Downstream Protection Layer

6.4.2 Proposed Spillway Configuration

The proposed spillway will consist of:

- A 10 m long ogee spillway on the left flank of the dam;

- An approach channel with an ogee weir of 1.5 m depth;
- A 177 m long chute, and
- A conventional hydraulic jump stilling basin at the end of the chute.

6.4.3 Proposed Outlet Works

The outlet works will consist of:

- An inlet structure with a dual pipe system for water supplied from Smithfield Dam to Langa Dam, and for water supply from Langa Dam to the Baynesfield WTP, and for emergency draw down, as well as
- An outlet structure to release the EWR and the existing water downstream water requirements from Langa Dam into the Mbangweni River.

A cylindrical tower with an inside diameter of 7.2 m is proposed for the outlet tower in order to accommodate two (2) 1.6 m diameter pipes at the bottom. These two 1.6 m diameter pipes will be for water that will be supplied to Langa Dam from Smithfield Dam, and for water that will be supplied from Langa Dam to the Baynesfield WTP. One of these 1.6 m diameter outlet pipes will suffice for water supply to the Baynesfield WTP, but the DWS requires a dual outlet pipe system. It is proposed that the EWR and downstream water requirements should also be released via one of these two 1.6 m diameter pipes.

The two (2) 1.6 m diameter outlet pipes will also be able to draw down Langa Dam from its FSL to 50% of its depth within 9.6 days, and the draw down to the lowest level will be achieved in less than 60 days.

6.4.4 River Diversion

The river diversion must be planned to be implemented in phases related to the changes indifferent seasons (high/low flow). The lower risk of flooding during the winter months (low flow season) must be considered when the construction programme is compiled. If another dam type, instead of a CFRD, is selected then a similar approach for the river diversion will be required. In addition to this the diversion tunnels will be used or form part of the outlet works.

6.5 Recommendations and Directives Arising from the Feasibility Design

Recommendations/directives arising from the feasibility design for the implementation of Langa Dam are the following:

- Additional test pitting, core drilling, sampling and laboratory tests must be undertaken by the Implementing Agent to confirm the properties and volumes of construction materials actually required, as well as to confirm the founding conditions for the selected dam type and the spillway structure;
- Review of the proposed ogee spillway with a chute on the left flank for a design discharge of 8.65 m^3/s during the detailed design phase;
- A seismic refraction survey should be undertaken by the Implementing Agent for the proposed dam site;
- The proposed configurations of the outlet tower that should be considered for detailed design are: (i) A cylindrical structure with an outside diameter of 11.2 m and an inside diameter of 7.2 m, or (ii) A square tower of 8.2 m x 8.2 m with a cylindrical shaft with a diameter of 7.2 m;
- It should be confirmed/decided whether the downstream projection layer for the selected dam type will be dolerite layer or vegetation, as well as
- A safety assessment for the existing Mbangweni Dam's spillway capacity must be undertaken during the detailed design phase for extreme flood events and/or failure of the transfer infrastructure.

7 ANCILLARY WORKS

7.1 ANCILLARY WORKS FOR SMITHFIELD DAM

7.1.1 Relocation of Water Treatment Plant

A package WTP in the dam basin must be relocated.

7.1.2 Relocation of Eskom Infrastructure

The current 88 kVA Eskom transmission line from Bulwer to Elandskop that traverses Smithfield Dam's basin can be raised to accommodate the 700 m affected span of the line across the to-be-impounded reservoir. Sufficient freeboard will be required to ensure safe recreational use of the reservoir and for dam safety surveillance. The customer executive for Eskom will need to be contacted to request a transmission line deviation project.

7.1.3 Roads

The following deviations of the existing public roads and permanent access roads to the dam are required:

- Deviation of Provincial Road R617 (12 km of the existing road), during the EIA Process substantial resistance against the re-alignment was experienced. The option presented in the EIR will require the de-proclamation of a section of the Impendle Nature Reserve. This option was not accepted by the KZN Department of Transport mainly due to substandard geometrics, specifically the steep slopes. Furthermore, EKZNW indicated that they have a problem in principal with allowing development in any nature reserve. For these reasons the investigation of alternative alignment options for Provincial Road R617 are currently underway, and the Implementing Agent should consider, and evaluate ,the proposed alternative alignment option/s for Provincial Road R617 in more detail.
- The Implementing Agent must also investigate the option of an additional smaller bridge that will be required for pedestrians, including school children, and cattle to cross the stream near the old Deepdale Bridge that will be inundated.. This option may, however, trigger a listed activity in terms of the NEMA EIA Regulations (2014) and the Implementing Agent must obtain the necessary approvals will be required from DEA. Consultation must also take place with the KZN Department of

Transport to determine the design and finalise post construction management.

- Gravel access road to Nonguqa, (a village on the southern side of the dam), as well as
- Proposed main access and construction road are located on the north-eastern side of the dam basin, and are mostly on the alignment of an existing route P124. A section of about 3.4 km of the existing Route P124 needs to be deviated for the 7.5 km main access road to the dam. This section of road will also be used to provide access to the construction camp during the construction phase. This section will be inundated during impoundment. These roads must be paved during construction and a new seal layer to be provided after construction;

The following new access roads are required:

- New gravel access roads to the tunnel inlet portal (0.23 km) and to the dam wall (1.56 km), turning off the main access road;
- New gravel access road to the gauging weir upstream of the dam (0.17 km);
- New gravel access road to the gauging weir downstream of the dam (2.16 km);
- New gravel access road to the EWR/IFR2 Site (2.516 km), and
- Any other access roads (temporary or permanent) that may be identified during the due diligence and optimisation investigations.

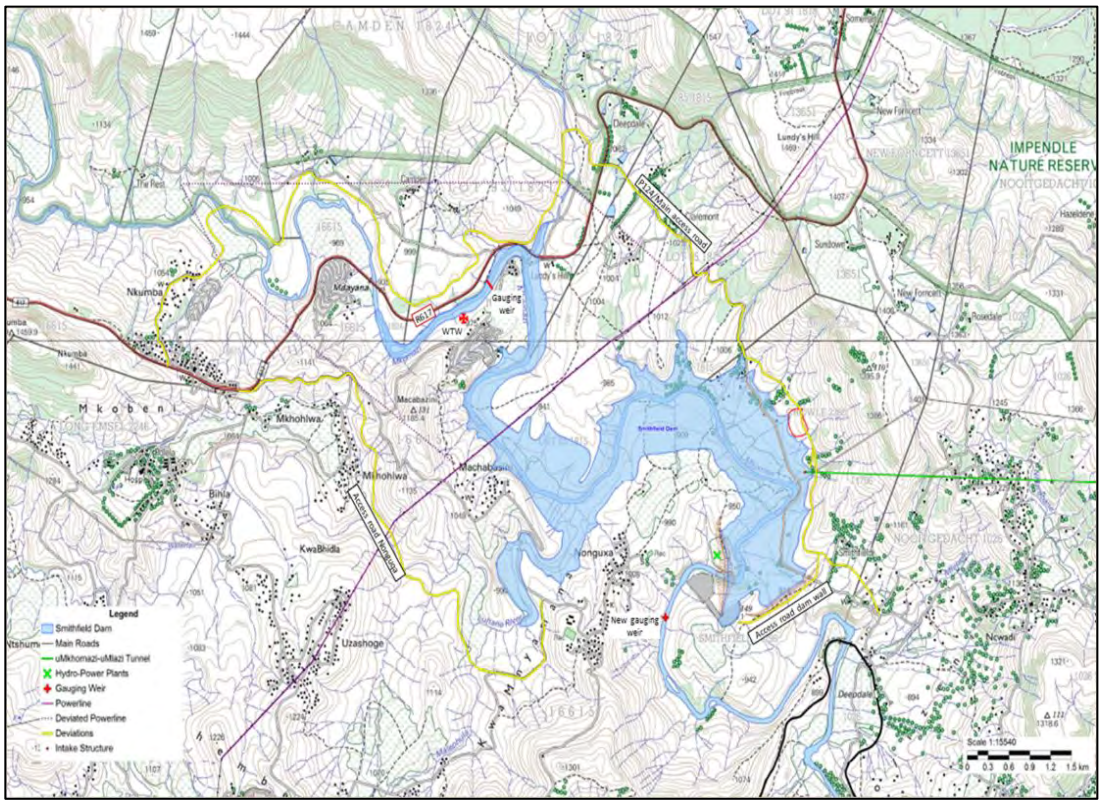


Figure 7.1: Existing Roads and other Infrastructure around Smithfield Dam

Recommendations/directives/further investigations arising from the feasibility design of road deviations and access roads are the following:

- Detailed topographical surveys must be performed for all the proposed routes during the detailed design phase;
- No geotechnical investigations were undertaken for the roads and should be undertaken by the Implementing Agent. It was, however assumed that road building material will be readily available from the quarries for the dams, but the Implementing Agent must undertake further investigations to confirm the suitability of these materials for the construction of roads, and
- No heavy construction vehicles will be allowed to use the access road from Provincial Road R617 to Ncwadi, as agreed during the EIA Public Participation Process (PPP), and consult the KZN Provincial Department of Transport for the design requirements for the different roads.

7.1.4 Flow Gauging Requirements Upstream and Downstream of the Dam

The following three (3) proposed flow gauging crump weirs will be required on the uMkhomazi River:

- Weir 1: Upstream of Smithfield Dam, to measure inflow into the dam (coordinates: **29° 39' 8.92"S, 29° 46' 29.65"E**);

- Weir 2: Downstream of Smithfield Dam to measure the smaller discharges from the dam, as well as the EWR releases (coordinates: **29° 46' 53.09"S, 29° 55' 52.70"E**), and
- Weir 3: Further downstream of Smithfield Dam, near the EWR Site 2, to determine the runoff from the incremental catchment downstream of Smithfield Dam, as well as to assist with the EWR and the monitoring thereof (coordinates: **29° 55' 12.31"S, 30° 5' 14.26"E**).

All three (3) weirs will be constructed as part of the uMWP-1. Weir 2 will replace the existing DWS Gauging Weir U1H005 on the uMkhomazi River, which will be inundated by Smithfield Dam. The DWS will provide the detailed designs (including telemetry requirements) to be implemented for the construction of the weirs. Weir 1 and Weir 3 are required, but were not part of the scope of work for the EIA Process. No geotechnical and materials investigations were undertaken for these flow gauging weirs as part of the feasibility investigations, and therefore the required geotechnical and materials investigations. The Implementing Agent must also undertake further additional work for Weir 1 and Weir 3, including an EIA, and all the necessary approvals as per the NEMA EIA Regulations (2014).

7.1.5 Hydropower Plant

An assessment of the economic viability of a HPP as part of the outlet works (releases into the river) of Smithfield Dam, concluded that wheeling power into the grid is a feasible HPP option. More detailed investigations should be undertaken by the Implementing Agent during the detailed design phase to confirm the feasibility and economic viability of such a HPP. The dam's outlet works should, however, should be designed as such that a powerhouse can be connected to the outlet pipes in future.

7.1.6 Waste Disposal Sites

A waste disposal site has been identified near the tunnel inlet portal for the disposal of about 600 000 m³ of spoil materials, specifically unsuitable excavated material from the tunnel boring process. Following a meeting held with the DEA during December 2014 and the DEA confirmed that the spoiling of excess soil and rock would not require a Waste Management Licence in terms of the Waste Act (Act No. 59 of 2008). The Integrated Application Forms were amended in this regard to only relate to NEMA activities.

Solid (municipal) waste generated during the construction process must be disposed of at legal/registered municipal waste disposal sites.

7.1.7 Accommodation and Related Structures

The accommodation and related structures requirements at Smithfield Dam for the operational phase should be concluded during the detailed design phase, and may include, amongst others, an office complex; operator and workers houses; a workshop; a boat store, as well as a package WTP and a package Waste Water Treatment Plant (WWTP). The designs for construction accommodation should, however, be as such so that it could be used for recreation purposes in future, as requested by an I&AP (the Baynesfield Estate) during EIA Process. The Baynesfield Estate will be the owners of this accommodation once construction has been completed.

7.2 Ancillary Works for the Proposed Bulk Raw Water Conveyance Infrastructure

7.2.1 Existing and New Roads

a) Temporary Access Roads

The permanent servitude roads along the tunnel; 2.6 m diameter raw water pipeline to the Baynesfield WTP and the take-off bi-directional 1.6 m diameter raw water pipeline to and from Langa Dam will also serve as the temporary access roads to the various infrastructure components during construction.

b) Permanent Access Roads

Where required, the afore-mentioned access roads along the tunnel and the raw water pipelines will be upgraded after construction to serve as the permanent servitude roads.

The other permanent access roads that will be accessed via the permanent servitude roads are the roads to the Ventilation Shaft 1 (70 m) and Ventilation Shaft 3 (68 m) of the tunnel as well as to the centre adit entry of the tunnel (about 2 km).

7.2.2 Hydropower Plant

Another possible HPP at the end of the of the 2.6 m diameter raw water pipeline, just before the outlet structure to the Baynesfield WTP has the potential to generate 3 MW (installed capacity).

More detail investigations should be undertaken by the Implementing Agent during the detailed design phase to confirm the feasibility and economic viability

of such a HPP. The dam's 2.6 m diameter raw water pipeline should, however, be designed as such that a powerhouse can be connected to the pipe in future just before the Baynesfield WTP.

7.2.3 Waste Disposal Sites

Two (2) waste disposal sites, one near the tunnel inlet portal and another one at mid-length along the tunnel length, near the tunnel access adits, have been identified for disposal of construction materials (spoil) that will mainly be excavated during construction of the tunnel as well as its inlet and outlet portals. These waste disposal sites and will be part of the EIA Application for the Project. Alternative arrangements will be subject to optimisation. Following a meeting held with the DEA during December 2014 and the DEA confirmed that the spoiling of excess soil and rock would not require a Waste Management Licence in terms of the Waste Act (Act No. 59 of 2008). The Integrated Application Forms were amended in this regard to only relate to NEMA activities. It was agreed with the manager of Baynesfield Estate that excavated material from the tunnel outlet portal will be used for the construction of Langa Dam, and therefore the development of another waste disposal site near the tunnel outlet portal will therefore not be necessary.

Solid (municipal) waste generated during the construction process must be disposed of at legal/registered municipal waste disposal sites.

7.3 Ancillary Works for Langa Dam

7.3.1 Relocation of Existing Infrastructure

No permanent infrastructure is located within the dam basin, and this was also confirmed during the EIA Process.

7.3.2 Existing and New Roads

a) Temporary Access Roads

Access to Langa Dam Site during construction will be along the existing P334 gravel road, turning off at about 3 km west of the Baynesfield Estate buildings (just before the piggery), past the Baynesfield Estate Lodge (adjacent to the existing Mbangweni Dam) and the tunnel outlet portal towards the proposed Langa Dam Site. The existing gravel road to Langa Dam (from the P334 turn-off) will have to be upgraded to accommodate the construction traffic. It is proposed that the existing long gravel road be upgraded to an 8 m wide layered and

compacted gravel road. The access road to the dam will be paved at the commencement of construction and re-sealed after the completion of construction. A final agreement, however, needs to be sought with Baynesfield Estate.

It is recommended that the Implementing Agent should undertake an investigation for the upgrading of a section of the existing P334 from the Baynesfield Estate buildings to the turn-off.

b) Permanent Access Roads

The proposed temporary access road to Langa Dam will be upgraded after construction, since this road will be the permanent access road to the dam.

Recommendations arising from the feasibility design for the roads are:

- Detailed topographical surveys must be performed for all the proposed routes during the detailed design phase, and
- No geotechnical investigations were undertaken for the roads and should be undertaken by the Implementing Agent, It was, however, assumed that road building material will be readily available from the quarries for the dams, but the Implementing Agent must undertake further investigations to confirm the suitability of these materials for the construction of roads. The Feasibility Study did, however, make provision for the importation of G5 materials from the Midmar Quarry, which is a distance of 64 km away from the proposed Langa Dam Site.

7.3.3 Flow Gauging Requirements Upstream and Downstream of the Dam

Langa Dam will be a balancing dam and no flow gauging structures will be required upstream or downstream of the dam. The natural inflow into the dam is minimal if compared to the dam's storage volume. The EWR and the releases for the downstream requirements will be regulated by means of the outlet valves (refer **Section 6.2.1** above).

7.3.4 Waste Disposal Site

Waste, specifically tunnel spoil and excavated material from the tunnel, and the tunnel outlet portal, will be accommodated in the construction of the dam wall (refer **Section 4.5.2** above). Following a meeting held with the DEA during December 2014 and the DEA confirmed that the spoiling of excess soil and rock would not require a Waste Management Licence in terms of the Waste Act (Act

No. 59 of 2008). The Integrated Application Forms were amended in this regard to only relate to NEMA activities.

Solid (municipal) waste generated during the construction process must be disposed of at legal/registered municipal waste disposal sites.

7.3.5 Accommodation and other Site infrastructure

Construction related accommodation and site infrastructures will be located in and near the dam basin. Permanent infrastructure required, such as office space, will be accommodated at the Baynesfield WTP.

8 IMPLEMENTATION PROGRAMME

A proposed construction programme for this comprehensive multidisciplinary project, including the principle work items, with the emphasis on the critical path activities is shown in **Appendix A**. The duration of the various activities are based on realistic construction production rates, and the proposed construction programme is based on the following milestone dates:

- Commencement of construction: 2020;
- Commencement of impoundment: December 2024, and
- Commencement of raw water supply to the Baynesfield WTP: December 2025.

When the construction programme was compiled it was assumed that appropriate time has been allocated to complete all the pre-construction activities, and preparations which include the following:

- Tendering process and contract award;
- Obtaining of relevant approvals, permits and licenses;
- Financing, and
- Land acquisition.

The important construction works for Smithfield Dam are the following:

- The excavation and lining of the dam's River Diversion Tunnel 2;
- The rock support of the dam's River Diversion Tunnel 1 has to be completed by the end of March 2021 to start diverting water through these tunnels;
- The proposed Roller Compacted Concrete (RCC) Cofferdam 5 must be completed before the summer rain season of 2021 to avoid possible flooding of the construction area and consequent damage and delay of construction;
- The proposed rockfill Cofferdam 6 must be completed before the summer rain season of 2022, and
- A large portion of the proposed saddle dam embankment should be completed prior to the commencement of the construction of the dam's main embankment since the shale to be used for the saddle dam's embankment

shell overlies the dolerite required for the shell of the main dam's embankment.

The important construction works for the raw water conveyance infrastructure are the following:

- The procurement, manufacturing, testing, shipping and assembling of the TBM for the construction of the tunnel;
- Provision of river crossing (for example pedestrian bridge);
- Erection of the crusher and batching plant;
- Drilling and blasting of the central access tunnel at mid length of the tunnel;
- Drilling and blasting of the tunnel's other access adits, and
- Boring and lining of the tunnel from chainage 33.1 km to chainage 15.2 km.

The construction of Langa Dam should be aligned with the construction of the tunnel as materials become available from the tunnel excavations. Langa Dam should therefore be completed at same time as the tunnel, and embankment rockfill material placement from the tunnel spoil should be planned carefully to avoid double handling of this material.

All the other construction activities (the construction of access roads; raw water pipelines; relocation of existing infrastructure; etc.) can be completed within the critical period, but these activities must be aligned and prioritised as such to ensure the efficient completion of the Project, as these activities could affect the critical path if not completed on time. The construction of the roads providing access to hard-to-reach construction sites have to be completed before the associated construction activity can commence, and this may require advance works to commence before September 2020. The proposed construction programme should be reviewed and adjusted accordingly after more accurate quantities and production rates have been established during the detailed design phase.

9 GENERAL CRITERIA

The uMWP-1 will be a government waterworks in terms of the National Water Act, (Act No. 36 of 1998) (NWA), Chapter 11. The implementation of the uMWP-1 must therefore adhere to the general criteria described in Chapter 11 of the NWA.

9.1 DESIGN GUIDELINES

The DWS design guidelines and specifications should be used together with other recognized standards; codes and acts such as those of the South African Bureau of Standards (SABS), South African National Standards (SANS) codes, the DWS standards, and the Occupational Health and Safety Act (Act No 85 of 1993) whilst applying professional expertise and sound engineering judgement.

Table 9.1: DWS Specifications for the Design of Water Infrastructure*

Number	Description
DWA 0510	Drilling and grouting
DWA 0750	Water retaining concrete
DWA 1110	Construction of pipelines (October 2010 revision)
DWA 1130	Design, manufacture and supply of steel pipes (October 2010 revision)
DWA 1131	Lining and coating of steel pipes and specials
DWA 1140	Design, manufacture and supply of asbestos-cement pressure pipes and joints
DWA 1150	Glass reinforced plastics (GRP) pipes and joints for use for water supply
DWA1160	Design, manufacture, supply, and installation of Polyvinyl Chloride (PVC) Pressure Pipes and fittings
DWA 1710	Bricklaying
DWA 1720	Plasterer, tiler, and floorer
DWA 1730	Glazing and painting
DWA 1740	Plumbing
DWA 1810	Specialist services
DWA 1910	Supply, delivery, installation and commissioning of mechanical and electrical equipment for a bio-filter plant
DWA 2010	Boundary fencing
DWA 2410	Landscaping
DWA 2510	Valves (set of specifications)
DWA 9900	Corrosion protection (set of specifications)
DWA GTE	General technical specifications (Electrical)

* *Latest specification to be used, also refer to the Design Criteria Memorandum*

9.2 Current Best Practices and Efficiency

Current best practices and efficiency shall be applied to the design; construction; supervision; commissioning and operation of the works. Where applicable the relevant international standards shall also be applied.

9.3 Electricity Supply

All power requirements, for both the construction and operational phases of the Project, should be confirmed during the detailed design phase. Power requirements during construction may be provided by the contractor if permanent electricity infrastructure has not been installed. The installation of Eskom infrastructure (transformers, transmission lines etc.) may trigger a listed activity in terms of the NEMA EIA Regulations. The Implementing Agent must therefore engage with Eskom at an early stage to expedite this.

9.4 Security Measures

The Project shall be implemented in compliance with the requirements for an Important Works as defined in the applicable legislation and the DWS Manual on Physical Security Measures at Departmental Works and Schemes.

The DWS agreed during a meeting of the Joseph Baynes Estate Trustees on 19 August 2014 that the construction sites will be fenced, and that construction workers may not move freely beyond the construction domain.

9.5 Advance Works

9.5.1 Preparation to Construct

The Implementing Agent will be required to:

- Obtain relevant Section 21 Water Use licences from the DWS and the licence/s to construct the dams from the DWS's Dam Safety Office;
- Develop specifications for contractors work area;
- Develop a detailed construction plan;
- Undertake further studies and to finalise the detailed Environmental Management Programme (EMPr) for construction and the Environmental Management Plan (EMP) for the development of quarries and borrow areas;
- Submit applications for power supplies for construction, and

- Liaise with the local authorities and the Traditional Leader/s regarding access to the various construction sites.

9.5.2 Construction

Any construction work undertaken in the river channels (uMkhomazi and Mbangweni Rivers) shall as far as possible be scheduled to take place during the dry season (winter) to avoid possible flooding and associated damage to the works during the wet season.

Construction activities shall be undertaken in compliance with the Project Specifications; the EA as well as the related EMPr and EMPs, which must have been approved by the relevant authorities. Method statements for all the construction activities must be consistent with these prescriptions so as to result in minimal and acceptable impact on the receiving environment.

The appointed contractor must also allow for sufficient time to restore/rehabilitate all the construction sites and disturbed areas to their original states upon completion of construction, strictly in accordance with the relevant specifications.

Construction housing for the permanent staff during construction from outside the Project Area must be identified. The contractor will be responsible for accommodation for the permanent staff during construction, in consultation with the Implementing Agent, municipalities and/or landowners.

9.6 Quality Assurance and Control

Quality assurance in terms of ISO 9001-2000 or functionally equivalent standards will be a requirement. All consultants and contractors shall be required to compile Quality Assurance Plans for the works and these shall be rigorously applied; monitored and reported on.

The quality control aspects will follow logically from the afore-mentioned processes where it will culminate in the production of suitable reports; drawings; specifications and manuals that will meet the Operational and Maintenance (O&M) requirements of the Project.

9.7 Operation and Maintenance

9.7.1 Operating and Control Philosophy

Appropriate communication, monitoring and control systems shall be provided to allow for the effective and efficient control of all components of the system that will be directed by the DWS in the Final RID.

9.7.2 Operation and Maintenance Requirements

The O&M requirements for all the infrastructure shall be included in the O&M Manual that must be prepared by the Implementing Agent, and must address the following

- A planned preventative maintenance approach to ensure a high level of assurance of supply;
- Infrastructure at the dams and other structures that will allow for the removal and loading of equipment onto vehicles for transport;
- Suitable maintenance and inspection procedures, including maintenance of an asset register, which must form part of the O&M Manual, and
- A strategic spares philosophy for the major equipment.

Time periods required to perform maintenance activities during scheduled downtimes must be determined, also taking account of seasonal operation requirements. The bulk water users will need to be notified in advance of any shutdowns for planned maintenance, and in case of shutdowns for emergency repairs the bulk water users will need to be notified as soon as possible.

Prior to handover, the Implementing Agent must ensure that all the operators receive training on minor maintenance works by the design engineers and the relevant contractors.

10 COMPLIANCE WITH APPLICABLE LEGISLATION, REGULATIONS AND POLICY

It will be the responsibility of the Implementing Agent and the Operating Entity to strictly adhere to all the relevant policies and legislation when implementing; operating and maintaining the scheme. This includes, inter alia, the NWA; Broad-Based Black Economic Empowerment (BBBEE) Amendment Act of 2013; Sustainable Utilisation Planning; the National Water Resources Strategy; the National Development Plan, and the Public Finance Management Act

Procurement procedures during implementation and operation of the scheme shall also comply with the relevant legislation, such as the Public Finance Management Act of 1999 and the BBBEE Amendment Act of 2013.

10.1 NATIONAL WATER ACT

A Notice of Intent to implement the uMWP-1 as a government waterworks in terms of Sections 109 & 110 of the NWA, and declaring the uMWP-1 as a government waterworks, will probably be published towards the end of 2018. Funding for the implementation of the Project will come from private funds and/or National Treasury. It is recommended that the Trans-Caledon Tunnelling Authority (TCTA) be appointed as the Implementing Agent for the uMWP-1. Since the uMWP-1 is earmarked to augment the Mgeni WSS it is recommended that UW will be the Operating Entity for the uMWP-1 on behalf of the DWS.

10.1.1 Land Matters

Section 64 of the NWA enables the Minister of Water and Sanitation, or a Water Management Institution authorised by the Minister in writing, to expropriate any property for any purposes contemplated by the NWA if the purchase is for public purposes or in the public interest. Servitudes with specific purposes can also be registered. Therefore, land rights (including servitudes and unregistered rights) to implement and operate the required infrastructure must be acquired in accordance the appropriate legislation. A title deed, as well as tribal land needs to be secured for the Project. Preliminary expropriation lines, depicting the minimum land purchase requirements for the construction of Smithfield and Langa dams as well as for the three (3) flow gauging weirs (where servitudes will be required), were determined according to the "*Policy and Guidelines for the Acquisition of Land Rights at Departmental Dams*" (DWAF, 2001). The estimated

total area of land to be expropriated is 1 661 Ha, and the total estimated area of land for which servitudes will need to be registered is approximately 157 Ha. Servitudes for the tunnel and infrastructure associated with the tunnel must be obtained. Land matters are sensitive issues, and specifically during the EIA Process and Feasibility Study indications are that these matters should be handled with great care, therefore a good ***Public Relations (PR) Team*** should be involved as soon as the Project is approved to avoid miscommunication that may result in possible delays. It is recommended that the same PR Team that was used during the Feasibility Study be employed for the duration of the project implementation phase.

10.1.2 License Requirements

A license to construct must be obtained from the DWS before work on the dams and flow gauging weirs may commence. A licence to impound water must also be obtained from the DWS at least 120 days after the date on which the dams and flow gauging weirs are capable to storing or impound water.

10.1.3 Water Use Licence

The Project entails the following activities that constitute water uses in terms of Section 21 of the NWA:

- Taking water from a water resource;
- Storing of water; (impeding or diverting the flow of water in a watercourse; flow gauging weirs, road realignment, access roads, raw water pipelines, tunnel, etc.), and
- Altering the bed, banks, course or characteristics of a watercourse.

A draft Integrated WULA for the uMWP-1 was, compiled by the Environmental Assessment Practitioner (EAP) for the Project as part of the EIA Process. This WULA must, however, be finalised and submitted by the Implementing Agent to the DWS KZN Regional Office for both construction and operational requirements.

10.2 Environmental Impact Assessment

10.2.1 General

The DEA rejected the EIA Report for the uMWP-1 Raw Water Component. After engagements with the DEA it became clear that additional technical and EIA work

will be required before the DEA will approve the applications for the Project. The following additional technical and EIA work are underway:

- A Noise & Vibration Impact Assessment pertaining to the tunnel construction;
- A Biodiversity Offset Assessment;
- An EIA for alternative tunnel routes, and
- Possible alternative realignment options of Provincial Road R617.

Upon completion of this additional technical and EIA, work and addendum to the EIR will be prepared, where after the EIR will be resubmitted to the DEA for approval, and the DEA's decision is expected by October 2018.The EIA also recommended that the EMPr be further developed to include the following EMPs as further information becomes available:

- A Search, Rescue and Relocation Management Plan;
- Impoundment EMPrs for Smithfield and Langa dams, as well as for the flow gauging weirs;
- A Rehabilitation Management Plan;
- An Operational EMPr, which will complement the O&M Manual, and
- A Resource Management Plan.

A full Scoping and separate DMR EIA Process are also underway for the quarries and borrow areas, based on the listed activities to be triggered, and will be undertaken by the DWS's Project Team (refer **Section 10.2.7** below).

10.2.2 Relocation of People

During the EIA approximately thirty (30) dwellings were identified in Smithfield Dam's basin that will have to be relocated. A Relocation Policy Framework (RPF) that was prepared during the EIA comprises the social principles for the relocation. This should be the basis for a Relocation Action Plan (RAP), which needs to be prepared in consultation with the stakeholders (directly and indirectly affected) during the implementation phase. The RAP must consider as a minimum, the stakeholder engagement process; compensation framework (loss of assets, access to resources, income sources and/ or livelihoods, etc.); relocation sites; an independent review of the process, and grievance mechanism/procedure.

10.2.3 Relocation of Graves and Mitigation of Impacts on Cultural and Historic Sites

A Phase 1 Heritage Impact Assessment (including an archaeological and paleontological assessment), in accordance with the National Heritage Resources Act (Act No. 25 of 1999) and the KZN Heritage Act (Act No. 04 of 2008), was undertaken as part of the EIA. Prior to construction a Phase 2 Heritage, Archaeological and Paleontological Impact Assessment must be undertaken by the Implementing Agent. The Implementing Agent must also develop a Grave Exhumation and Reburial Strategy in accordance with the relevant legislation that takes due cognisance of the cultural sensitivities; customs; beliefs and ceremonies with regard to the exhumation and relocation of graves.

10.2.4 Resource Management Plan

The uMWP-1 (Smithfield and Langa dams) and surrounding landing land must be conserved and utilised in an environmentally sound and equitable manner. The Implementing Agent will be required to prepare and submit a Resource Management Plan (RMP) to the DWS for gazetting by the Minister of Water and Sanitation prior to the handover of the works for operation. This activity shall commence at the start of the implementation phase as it may be necessary to acquire land and/or land rights to implement the requirements of the RMP. The RMP must be prepared in accordance with the Department of Water Affairs and Forestry (DWAF) 2006 Recreational Water Use Manual and any subsequent amendments thereof.

10.2.5 Rehabilitation Management Plan

Although provision is made in the EMPr for the construction phase of the Project, the EIA recommended that a dedicated Rehabilitation Management Plan be compiled. This plan must include additional site-specific measures identified during construction to supplement the reinstatement and rehabilitation provisions included in the EMPr. The EA may also require that the Rehabilitation Management Plan be approved by the DEA.

10.2.6 General Mitigation of Environmental Impacts

Specific mitigation measures to safeguard sensitive environmental features and to prevent, minimise or rehabilitate impacts associated with the Project's life-cycle are included in the EIA Reports and the EMPrs.

Some of the key recommendations (not already discussed above) from the EIA are the following:

- Waste disposal sites (tunnel inlet and central portals) to avoid drainage lines;
- Specialist (avifaunal, terrestrial and aquatic ecological, heritage) walk-through to be performed on the site as part of the site specific EMPrs prior to construction;
- Engage further with EKZNW regarding extension of the Impendle Nature Reserve as a biodiversity offset for the Project;
- Investigate the relocation of dwellings on the north-eastern side of Smithfield Dam prior to construction in order to avoid construction-related impacts to the occupants;
- Provide suitable cover for the road surface for the access road to the tunnel outlet portal and Langa Dam on the Baynesfield Estate;
- Support targeted investment in the maintenance and rehabilitation of ecological infrastructure (functioning ecosystem with associated services) in the uMkhomazi River Catchment;
- Establish an Environmental Monitoring Committee (EMC) during the pre-construction phase;
- The Baynesfield Estate Lodge is located adjacent to the existing Mbangweni Dam and currently offers tourist accommodation, recreational fishing on the dam and environmental education opportunities. To mitigate the impacts to the Baynesfield Estate Lodge during the construction phase it is recommended that this facility be recreated to the existing Baynesfield Dam. The existing Baynesfield Estate Lodge could be leased out to the construction team and then be reinstated (as necessary) after the construction period for continued future use.

10.2.7 Scoping, EIA and EMPr for the Quarries and Borrow Areas

In terms of the Minerals and Petroleum Resources Development Act (Act No. 28 of 2002), applications to the DMR for authorisation to extract naturally occurring construction materials are required. The EMPr for the quarries and borrow areas was prepared and is attached to the EIA Report. A full Scoping and separate DMR EIA Process are currently underway for the quarries and borrow areas, based on the listed activities to be triggered. Upon completion of the Scoping and DMR EIA Process, the regulated timeframes in the EIA Regulations of 2014 will apply, and the DMR's decision is expected by July 2018.

11 FUNDING AND INSTITUTIONAL ARRANGEMENTS

11.1 COST ESTIMATE FOR SMITHFIELD DAM

A summary of the cost estimates for Smithfield Dam, including its associated infrastructure, for which the base date is March 2014, excluding VAT is provided in **Table 11.1** below. The detailed cost estimates for each component are contained in the *Engineering Feasibility Design Report (P WMA 11/U10/00/3312/3/1)*.

Table 11.1: Summary of Cost Estimate for Smithfield Dam and its Associated Infrastructure (2014 Rands)

Description	Cost (R million, excl. VAT)
River Diversion Works	178.5
Development of Quarries and Borrow Areas	9.9
Smithfield Dam Main Embankment (zoned ECRD)	813.5
Smithfield Dam Saddle Embankment (zoned earthfill dam)	252.1
Main Embankment Side-channel Spillway	189.7
Saddle Embankment Fuse Plug Spillway	66.0
Outlet Works and Intake Structure	146.4
Tunnel Intake Structure	288.4
Access Roads and Deviation of Roads	*179.8#*
Flow Gauging Weirs	28.8
Waste Disposal Site 1	7.1
Transmission Lines	5.0
Proposed Smithfield Dam HPP	*36.6**
Miscellaneous	85.8
TOTAL	**2 287.6**

* *Potential HPP cost is included although not part of the scope for the uMWP-1.*

\# *Will change given the revised realignment of Provincial Road R617.*

11.2 COST ESTIMATE FOR THE BULK RAW WATER CONVEYANCE INFRASTRUCTURE

A summary of the cost estimates for the bulk raw water conveyance infrastructure up to the Baynesfield WTP, for which the base date is March 2014, excluding VAT are provided in **Table 11.2** below. The detailed cost estimates for each component are contained in the *Engineering Feasibility Design Report (P WMA 11/U10/00/3312/3/1)*. This cost estimate includes the assumption that the tunnel

will be lined, until proven not required through detail geotechnical investigations either during the detailed design phase and/or construction.

Table 11.2: Summary of Cost Estimate of all activities for the Raw Water Conveyance Infrastructure to the Baynesfield WTP

Description	Cost (R million, excl. VAT)
Tunnel	
Transfer Tunnel (Tunnel 1)	3 362.2
Access and Deviation of Roads	11.9
Waste Disposal Site 2	7.1
HPP before the Baynesfield WTP	*42.8**
Miscellaneous	542.2
Total	**3 966.2**
Raw Water Pipelines	
Raw Water Pipeline to the Baynesfield WTP- 2.6 m diameter section	277.3
Take-off Raw Water Pipeline to and from Langa Dam - 1.6 m diameter section	27.0
Total	**304.3**
Total for the Raw Water Conveyance Infrastructure	**4 270.5**

* *Potential HPP cost included, although not part of uMWP-1 Project cost*

11.3 Cost Estimate for Langa Dam

A summary of the cost estimate, base date of March 2014 and excluding VAT, for the construction of all the components of Langa Dam is given in **Table 11.3** below. The detailed cost estimates for each component are contained in the *Engineering Feasibility Design Report (P WMA 11/U10/00/3312/3/1)*. The Langa Dam option, and/or the position of Langa Dam, might also change.

Table 11.3: Summary of Cost Estimate for the Components of Langa Dam

Description	Cost (R million, excl. VAT)
River Diversion Works	1.4
Development of Quarry	0.5
Langa Dam Main Embankment (CFRD)	315.8
Spillway	3.6
Outlet Pipes	12.8
Outlet Works and Intake Structure	47.1
Access and Deviation of Roads	28.9
Miscellaneous	120.0
TOTAL	**530.1**

Note: Additional R11.23 million (excl. VAT) to be added to total for vegetation downstream protection alternative.

11.4 Total Project Cost[1]

The total estimated capital costs of the uMWP-1's Raw Water Component, March 2014 prices excluding VAT, are given in **Table 11.4** below.

Table 11.4: Estimated Total Capital Cost of the Proposed uMWP-1

Raw Water Component	Cost (R million)[$]
• Proposed Smithfield Dam	2 030
• uMkhomazi – uMlaza Tunnel	3 904
• Proposed Langa Dam	501
• Baynesfield 2.6 m diameter raw water pipeline	277
• Langa Dam 12.6 m diameter raw water take-off pipeline	27
• Transmission lines	5
• Proposed Smithfield Dam and Baynesfield HPPs	79
• Waste disposal sites	15
• Flow gauging weirs	29
• *Roads and bridges*	*221[@]*
Sub-total of activities	**7 088**
Preliminary & General items (25% of activity cost)	1 772
Professional fees (12% of activity cost)	851
Environmental, landscaping and social costs (lump sum)*	450
Land acquisition (lump sum)	37
Sub-total of activities and value-related costs	**10 198**
Contingencies (25% of above sub-total)	2 550

[1] *Project cost shown in 2014 Rands from the Feasibility Study. Refer to the latest Project Concept Note for updated capital projections.*

Raw Water Component	Cost (R million)[$]
Implementing Agent - TCTA (lump sum)	200
Total: Raw Water System	**12 948**
Total: Potable Water System	**3 591**
Total Integrated uMWP-1 (excl. VAT)[#]	**16 539**
Total Integrated uMWP-1 (incl. VAT) 2014 Rands	**18 855**
Total escalated @ 6%/a to 2020 – start of implementation	**26 745**
Total escalated @ 6%/a to 2025 – completion of the Project	**35 791**

* *Provisional cost estimate, to be defined during the EIA Process.*

[#] *No financing cost included*

[$] *Cost based on current practices and additional cost due to new government policies, e.g. the Broad-Based Black Economic Act, 2013, has not been included.*

[@] *Will change given the revised realignment of Provincial Road R617*

11.5 Funding Arrangements

The envisaged beneficiaries of the uMWP-1, i.e. users supplied by the Mgeni WSS, will be in a position to generate an income stream from water tariffs that can contribute towards the recovery of the capital cost of the works. It is, however, recognised that a significant portion of the beneficiaries (households) that use about 25% of the current supplies from the Mgeni WSS, are regarded as low income households below the poverty line that qualifies for free basic water. The Project, which is a large capital project, together with recently constructed MMTS-2, has a significant impact and may cause 'financial strain' on these users.

The Feasibility Study therefore recommended that the raw water component of the uMWP-1 to be partially funded (approximately 25%) on-budget by National Treasury. Funding from National Treasury for the 25% social component is, however, highly unlikely and therefore a 100% Off-budget Funding Model for the Project should be further developed. National Treasury did not entirely dismiss that they would be unable to fund the entire Project, as this will depend on the country's general economic performance.

The costs of the uMWP-1, including loan redemption should therefore be recovered through UW's potable water sales.

11.6 INSTITUTIONAL ARRANGEMENTS

11.6.1 National Water Resources Infrastructure

The water resources infrastructure constituting the uMWP-1 will be classified as ***National Water Resources Infrastructure***[2], as per Section 109 of the NWA, and the DWS was assigned the responsibility as promoter and owner of the Project, by the Minister of Water and Sanitation.

11.6.2 Water Services Infrastructure

Distinction should be drawn between the national water resources infrastructure as described above and water services infrastructure (mostly the bulk potable water and reticulation infrastructure). Water services infrastructure is, however, the responsibility of the relevant WSAs, which are either the DMs and/or LMs.

Without the uMWP-1 there would not be sufficient water in UW's area of supply for the provision of water services provision, whilst without water services infrastructure it would not be possible to distribute potable water to the end users.

Smithfield Dam is located within the Ingwe LM, which is part Harry Gwala DM (the WSA in the area), and as noted in **Section 4.2.7** above, water will be allocated for supply to the communities surrounding Smithfield Dam. The Harry Gwala DM will, in consultation with DWS, plan and develop the water services infrastructure for this area.

11.6.3 Responsibilities for Implementation, Preparation and Management

It is recommended that both TCTA and UW be appointed to jointly undertake the pre-implementation work required for the raw water component of the uMWP-1, comprising Smithfield Dam; the Raw Water Conveyance Infrastructure to the Baynesfield WTP; Langa Dam; the Bi-directional Take-off Pipeline to and from Langa Dam as well as other appurtenant infrastructure. The TCTA and UW will be required to jointly develop a funding and cost recovery plan.

As the owner of the raw water component of the uMWP-1, the DWS will have overall responsibility for the management, as well as the O&M of the Project. Although the DWS retains direct responsibility for the water resources systems, it is recommended that UW be directed to be the Operating Entity for the uMWP-1, as per current management of the Mgeni WSS.

12 CONSTRUCTION PROGRAMME

The proposed construction programme for the uMWP-1's raw water component is based on commencement of construction in 2020 and is shown on the Proposed Implementation Schedule in **Appendix A**. The estimated completion date for the construction activities is end 2025.

13 REPORTING

The Implementing Agent; DWS National Water Resources Infrastructure (NWRI) Branch, or its delegated agent, shall take the responsibility to manage and organise the implementation of the Project, including reporting to the following committees[3]:

- The DWS top management;
- The uMWP-1 TC, at a higher level than the Project Coordination Committee (PCC) (described below), might be required as well and it would then be necessary to streamline the composition of the PCC, and
- The PCC, chaired by DWS CD: ID, and attended by, among others, the following DWS directorates and offices: NWRI Branch, IWRP, Water Services, Hydrological Services, and the DWS KZN Regional Office. The PCC must also be attended by UW and the TCTA, if directed by the Minister to implement the scheme. UW shall represent the municipalities and other end users on the PCC, and may choose to involve the WSAs, namely the eThekwini MM, Msunduzi LM, Ingwe LM, iLembe DM, Ugu DM and the uMgungundlovu DM.

Reporting to the uMWP-1 TC and PCC shall be both written and verbal, bearing in mind the diversity of representation on the uMWP-1 TC, i.e. Departmental; National and Provincial Government; WSAs; etc.

13.1 MONTHLY PROGRESS REPORTS

For purposes of monitoring progress of implementation a Monthly Progress Report shall be prepared within the DWS: NWRI Branch. This report shall as a minimum cover the following:

- Actual progress against the approved construction programme;
- Cash flow against approved budget;
- Utilization of resources (plant and labour);
- Local employment versus set or agreed targets;
- BBBEE involvement against targets;

- Problems and mitigation measures in respect of meeting programme milestones/deliverables, and
- Any deviations regarding the configuration of the approved Project.

13.2 Six-monthly Progress Reports

A concise Bi-annual Summary Report must be submitted to the Minister and the DWS top management, covering all issues discussed in the monthly progress reports of the preceding six (6) months. This report will also take cognisance of the requirements set out in the Ministerial Directive (if relevant) for the implementation of the Project.

13.3 Format and Distribution of Reports

- All reports shall be provided with the official name of the Project followed by the name; date and number of the report, e.g.:
  - Project name: uMkhomazi Water Project, Phase 1 (uMWP-1)
  - Report type: Monthly Progress Report and Bi-annual Summary Report.
  - Reporting period: (month & year) to (month & year)
  - Date: (month and year that report was issued)
- All reports shall be signed off by the responsible official within the DWS: NWRI Branch before distribution.
- All reports shall be distributed in both hardcopy and electronic (PDF) format.
- Copies of the progress reports shall be distributed to the responsible officials within the DWS: NWRI Branch; the Chief Director: IWRP; the Director: Options Analysis and the responsible Chief Engineer: Options Analysis. All reports shall also include the distribution list.

14 LIST OF FEASIBILITY STUDY REPORTS

This report forms part of the series of Feasibility Study Reports that were compiled for both the raw water and potable water components of the ***uMWP-1***.

Table 14.1: List of Feasibility Study Reports for the uMWP-1

Report Number	Report Title	Supporting Document Title
Technical Feasibility Study Raw Water - Module 1*		
P WMA 11/U10/00/3312	Inception Report	-
P WMA 11/U10/00/3312/1	Main Report	-
P WMA 11/U10/00/3312/1/1	Summary Report	-
P WMA 11/U10/00/3312/2/1	Hydrological Assessment of the uMkhomazi River Catchment	-
P WMA 11/U10/00/3312/2/1/1	Hydrological Assessment of the uMkhomazi River Catchment	Supporting Document 1: Groundwater Resources of the uMkhomazi Catchment and Interaction with Surface Water
P WMA 11/U10/00/3312/2/2	Water Requirements and Return Flows	-
P WMA 11/U10/00/3312/2/2/1	Water Requirements and Return Flows	Write-up 1: Possible Water Supply from Smithfield Dam to Surrounding Communities (Smithfield Dam local WSS)
P WMA 11/U10/00/3312/2/2/2	Water Requirements and Return Flows	Write-up 2: Community Supply From Smithfield Dam: Pre-feasibility Study
P WMA 11/U10/00/3312/2/3	Water Resources Yield Assessment	-
P WMA1 1/U10/00/3312/2/3/1	Water Resources Yield Assessment	Supporting Document 1: Sediment Yield Report
P WMA 11/U10/00/3312/2/3/2	Water Resources Yield Assessment	Supporting Document 2: Sediment Deposition and Impact Report
P WMA 11/U10/00/3312/2/4	Water Resources Planning Model	-
P WMA 11/U10/00/3312/3/1	Engineering Feasibility Design Report	-
P WMA11/U10/00/3312/3/1/1	Engineering Feasibility Design Report	Supporting Document 1: Optimisation of Conveyance System Report
P WMA11/U10/00/3312/3/1/2	Engineering Feasibility Design Report	Supporting Document 2: Dam Position Report
P WMA 11/U10/00/3312/3/1/3	Engineering Feasibility Design Report	Supporting Document 3: Optimization of Scheme Configuration
P WMA 11/U10/00/3312/3/1/4	Engineering Feasibility Design Report	Supporting Document 4: Cost Model
P WMA 11/U10/00/3312/3/1/5	Engineering Feasibility Design Report	Supporting Document 5: Dam Type Selection
P WMA 11/U10/00/3312/3/1/6	Engineering Feasibility Design Report	Write-up 1: Climatological Data for the Proposed Smithfield Dam and Langa Balancing Dam Construction
P WMA 11/U10/00/3312/3/1/7	Engineering Feasibility Design Report	Write-up 2: Water Quality and Limnological Review

Report Number	Report Title	Supporting Document Title
P WMA 11/U10/00/3312/3/1/8	Engineering Feasibility Design Report	Write-up 3: Site Investigation for the Positioning of Gauging Weirs
P WMA 11/U10/00/3312/3/1/9	Engineering Feasibility Design Report	Write-up 4: Route Investigation for Various Road Alignments on the uMkhomazi-uMlaza Transfer Scheme
P WMA 11/U10/00/3312/3/1/10	Engineering Feasibility Design Report	Write-up 5: Traffic Impact Assessment
P WMA 11/U10/00/3312/3/1/11	Engineering Feasibility Design Report	Write-up 6: Climate Change
P WMA 11/U10/00/3312/3/2/1	Geotechnical Report	Supporting Document 1: Probabilistic Seismic Hazard Analysis for Smithfield Dam, Langa Balancing Dam and the Conveyance System
P WMA 11/U10/00/3312/3/2/2	Geotechnical Report	Supporting Document 2: Seismic Refraction Investigation at the Proposed uMkhomazi Water Project Phase 1
P WMA 11/U10/00/3312/3/2/3	Geotechnical Report	Supporting Document 3: Smithfield Dam: Materials and Geotechnical Investigation
P WMA 11/U10/00/3312/3/2/4	Geotechnical Report	Supporting document 4: Langa Dam: Materials and Geotechnical Investigation
P WMA 11/U10/00/3312/3/2/5	Geotechnical Report	Supporting Document 5: Conveyance System: Materials and Geotechnical Investigation
P WMA 11/U10/00/3312/3/3	Hydropower Assessment Report	-
P WMA11/U10/00/3312/3/3/1	Hydropower Assessment Report	Supporting Document 1: Interim Investigation for Hydropower Potential at Impendle Dam and Transfer System
P WMA 11/U10/00/3312/4	Record of Implementation Decisions	-
P WMA 11/U10/00/3312/5	Institutional and Financial Aspects Report	-
P WMA 11/U10/00/3312/6	Economic Impact Assessment Report	-
P WMA11/U10/00/3312/6/1	Economic Impact Assessment Report	Supporting Document 1: Baseline Socio-economic Assessment
P WMA11/U10/00/3312/6/2	Economic Impact Assessment Report	Write-up 1: Detailed Socio-economic Baseline Study of the Umgeni Supply Area
P WMA 11/U10/00/3312/7	Environmental Screening Report	-
Environmental Impact Assessment - Module 2[$]		
P WMA 11/U10/00/3413/1	Environmental Impact Assessment: Inception Report	-
P WMA 11/U10/00/3413/2	Environmental Impact Assessment: Scoping Report	-
P WMA 11/U10/00/3413/3	Environmental Impact Assessment: Environmental Impact Assessment Report	-
P WMA 11/U10/00/3413/4	Environmental Impact Assessment: Environmental Management Report	-

Report Number	Report Title	Supporting Document Title
Module 3 - Potable Water#		
UW 108/114/12/R1-1	Main Report – Volume 1	-
UW 108/114/12/R1-2	Main Report - Volume 2 (Drawing Book)	
UW 108/114/12/R2	Preliminary Pricing of Potable Water Module Options	-
UW 108/114/12/R3	Water Demand Projections and Phasing of Infrastructure	-
UW 108/114/12/R4-1	Pipeline Design Report – Volume 1	-
UW 108/114/12/R4-2	Pipeline Design Report – Volume 2	-
UW 108/114/12/R4-3	Pipeline Design Report – Volume 3	-
UW 108/114/12/R4-4	Pipeline Design Report – Volume 4	-
UW 108/114/12/R5	Water Treatment Works Conceptual Design	-
UW 108/114/12/R6	Revised Mgeni System Operating Rules During uMkhomazi Raw Water Tunnel Shutdowns	-
UW 108/114/12/R8-1	Geotechnical Investigation Report - Volume 1 (Raw Water Pipeline)	-
UW 108/114/12/R7	Environmental Impact Assessment Report	-
UW 108/114/12/R8-2	Geotechnical Investigation Report - Volume 2 (Potable Water Pipeline)	-
UW 108/114/12/R8-3	Geotechnical Investigation Report – Volume 3 (Water Treatment Works)	-
UW 108/114/12/R8-4	Geotechnical Investigation Report – Volume 4 (Mapstone Dam Crossing)	-
UW 108/114/12/R9	Land Survey and Landowner Details	-

* *All reports titles for Module 1 include **"The uMkhomazi Water Project Phase 1: Module 1: Technical Feasibility Study Raw Water"***

$ *All reports titles for Module 2 include **"uMkhomazi Water Project Phase 1: Module 2: Environmental Impact Assessment"***

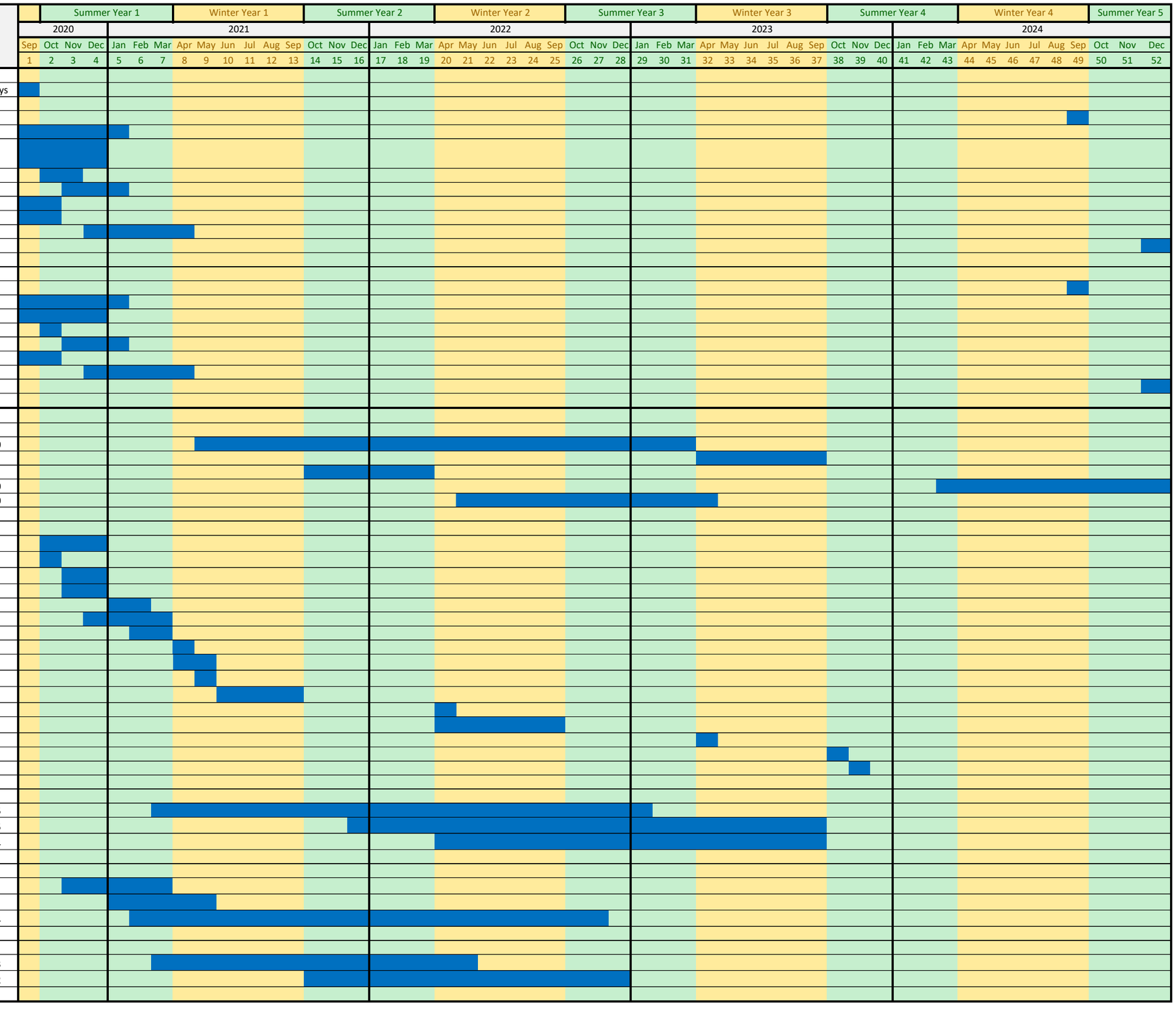
\# *All reports titles for Module 3 include **"uMkhomazi Water Project: Module 3: Potable Water Module"***

Appendix A

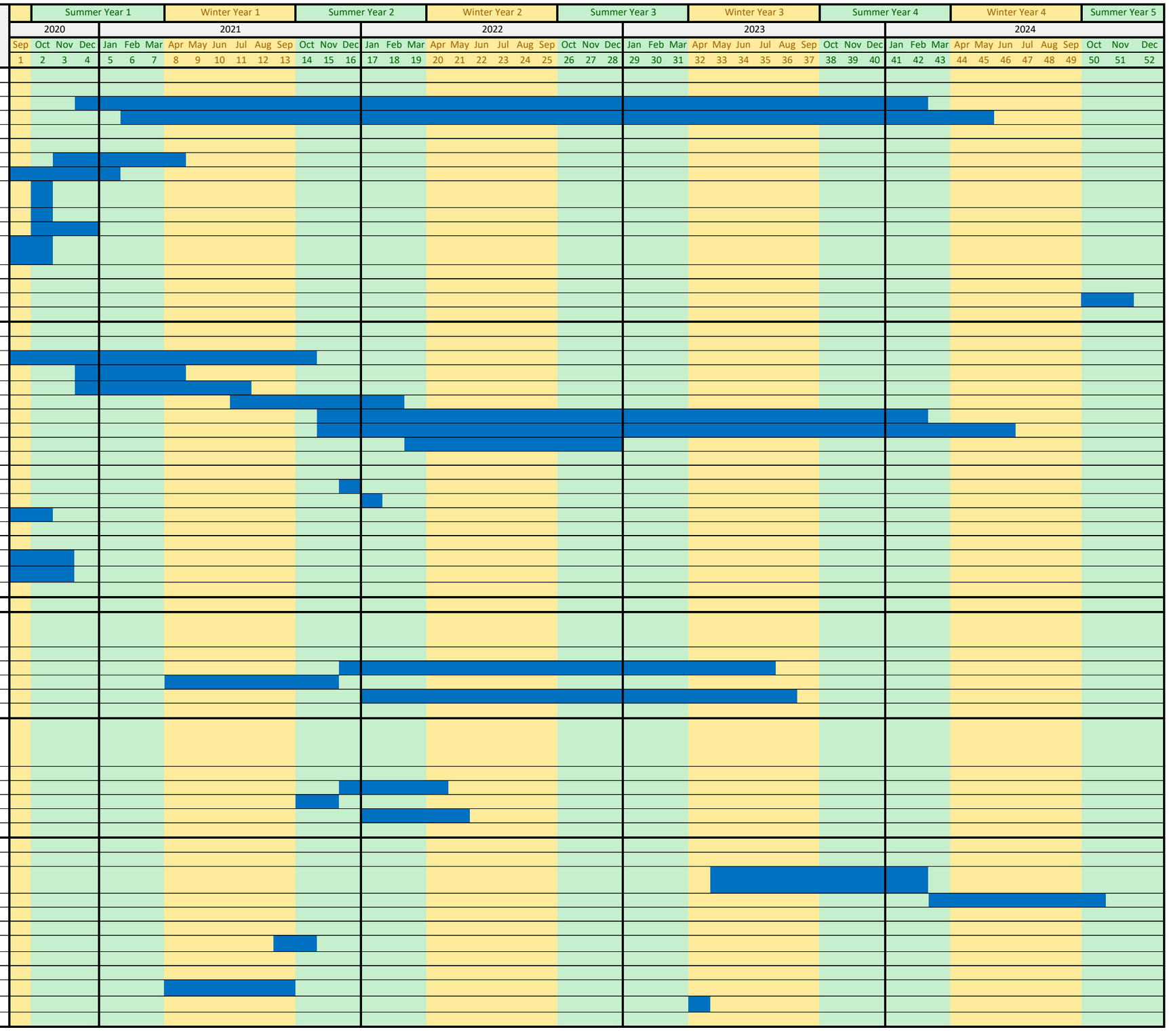
uMkhomazi-Umgeni Water Transfer Scheme - Phase 1: Raw Water Component

Engineer's Construction Programme

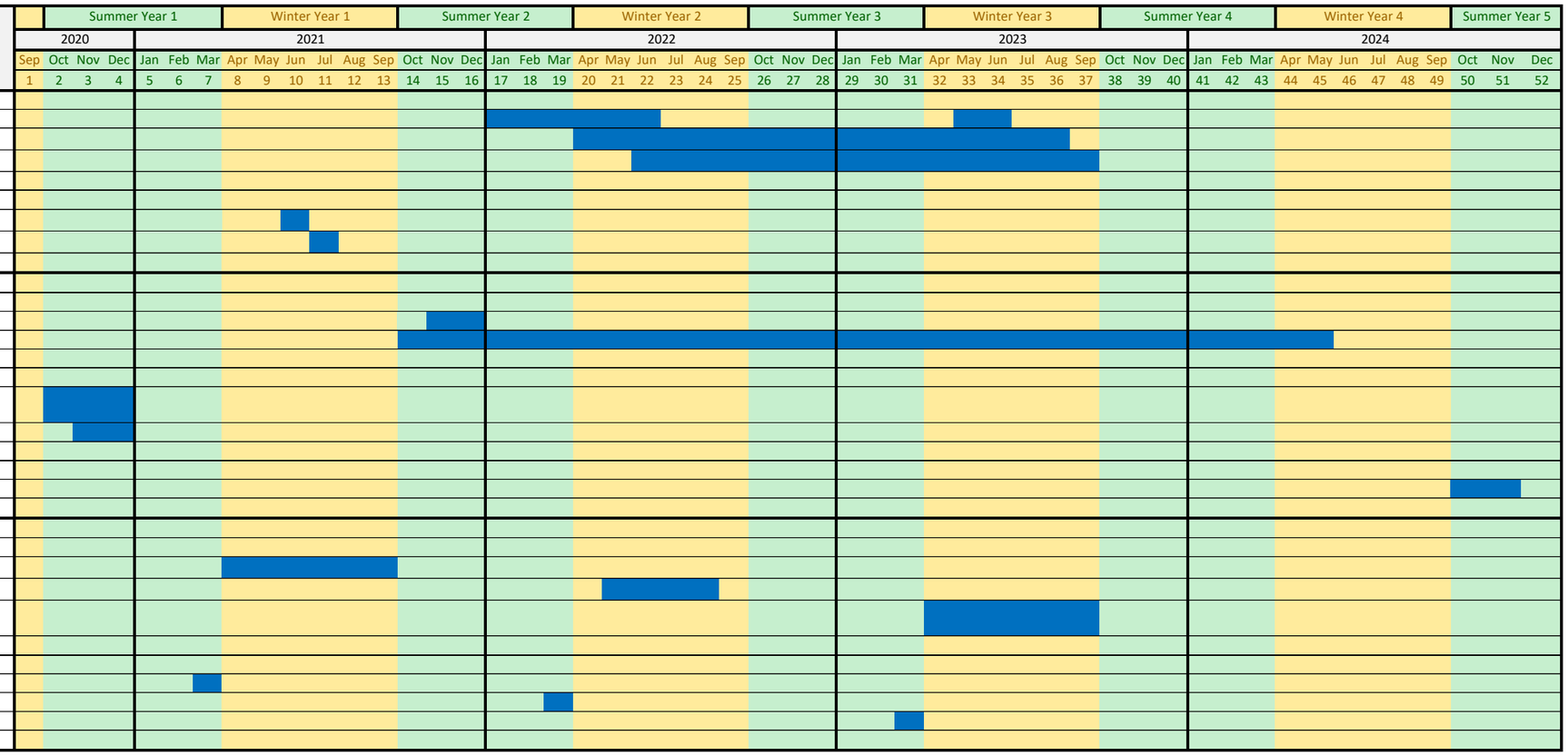
Activity	Unit	Quantity	Rate/month	Months
PROJECT GENERAL ITEMS				
Construction Contract Award				10 days
Smithfield Dam:				
Commencement of Supply	No.	1	1.00	1.0
Mobilisation	No.	1	0.20	5.0
Site and Engineers' Offices - incl. services	No.	1	0.25	4.0
River Crossing	No.	1	0.50	2.0
Erect Crusher and Batching Plant	No.	1	0.33	3.0
Establish Sand Screening Plant	No.	1	0.50	2.0
Establish Site Laboratory	No.	1	0.50	2.0
Preparation of Quarry and Aggregates	No.	1	0.20	5.0
De-mobilise	No.	1	1.00	1.0
Langa Dam:				
Commencement of Supply	No.	1	1.00	1.0
Mobilisation	No.	1	0.20	5.0
Site and Ennigeers' Offices - incl. services	No.	1	0.25	4.0
River Crossing	No.	1	1.00	1.0
Erect Batching Plant	No.	1	0.33	3.0
Establish Site Laboratory	No.	1	0.50	2.0
Sourcing of Quarry and Aggregates	No.	1	0.20	5.0
De-mobilise	No.	1	1.00	1.0
SMITHFIELD DAM				
General				
River Diversion through Two Tunnels	No.	1	0.04	23.0
River Diversion through One Tunnel	No.	1	0.17	6.0
River Diversion over Cofferdam 5	No.	1	0.17	6.0
Commencement of Impoundment	No.	1	0.10	10.0
Upgrading of Transmission Lines	No.	1	0.08	12.0
Diversion Works				
Excavate Portals	m^3	300,000	100,000	3.0
Construct Coffer Dam 1	m^3	880	1,500	0.6
Construct Coffer Dam 2	m^3	2,170	1,500	1.4
Tunnel 1 Excavation	km	0.40	0.25	1.6
Tunnel 2 Excavation	km	0.40	0.25	1.6
Tunnel 1 Lining	km	0.40	0.10	4.0
Tunnel 2 Support	km	0.40	0.25	1.6
Remove Coffer Dams 1 and 2	No.	1	1.00	1.0
Coffer Dam 3	m^3	5,460	3,000	1.8
Coffer Dam 4	m^3	10,320	10,000	1.0
Coffer Dam 5	m^3	2,970	900	3.3
Remove Coffer Dam 3	No.	1	1.00	1.0
Coffer Dam 6	m^3	822,165	150,000	5.5
Plug Tunnel 1	No.	1	1.00	1.0
Plug Tunnel 2	No.	1	1.00	1.0
Reinstate access between Tunnels	No.	1	1.00	1.0
Main Dam Embankment (ECRD)				
Curtain Grouting	m	23,063	1,320	17.5
Main Dam Core	m^3	855,775	46,200	18.5
Main Dam Rockfill	m^3	3,599,640	220,000	16.4
Saddle Dam (Zoned Earthfill)				
Saddle Dam Curtain Grouting	m^3	6,650	1,320	5.0
Saddle Dam Core (zoned earthfill)	m^3	199,900	46,200	4.3
Saddle Dam Outer Zones (zoned earthfill)	m^3	990,500	46,200	21.4
Spillway				
Excavation	m^3	1,687,686	110,000	15.3
Structures	m^3	50,000	3,300	15.2



Activity	Unit	Quantity	Rate/month	Months
Time (years)				
Time (Months)				
Time (Month numbers)				
SMITHFIELD DAM				
Outlets				
Intake Tower of the Outlet works	m	77	2	38.5
Intake to the uMkhomazi-uMlazi Tunnel	m	59	1.50	39.3
Access Roads				
Deviation of Road R617	km	12.06	2	6.0
Access Road to Nonguqa	km	8.13	2	4.1
Access Road to Tunnel Inlet Portal/Intake to Tunnel	km	0.23	2	0.1
Access Road to Main Dam Embankment	km	1.56	2	0.8
Construction Road	km	5.82	2	2.9
Access Road to Dam Outlet Works (Intake Tower to Dam)	km	3	2	1.5
Finishing and Rehabilitation of Site				
Rehabilitation of Site	No.	1	0.50	2.0
uMKHOMAZI-uMLAZI TUNNEL				
General				
Mobilization and Erection of TBMs	No.	1	0.07	14.0
Excavation of Portals	m^3	1,500,000	300,000	5.0
Central Access Tunnel and Mid-section	km	2	0.25	8.0
Other Access Adits	km	2	0.25	8.0
Tunnel: Chainage 14.8 km to 0 km	km	13.80	0.49	28.0
Tunnel: Chainage 33.1 km to 15.2 km	km	15.50	0.49	31.5
Shafts	m	270	40	6.8
Access Roads				
Access Road to Ventilation/Air Shaft 2	km	0.07	2	1.0
Access Road to Ventilation/Air Shaft 3	km	0.07	2	1.0
Access Road to Centre Adit Entry	km	2.10	2	1.1
Waste Disposal Sites				
Waste Disposal Site 1	m^3	600,000	200,000	3.0
Waste Disposal Site 2	m^3	550,000	200,000	2.8
uMLAZI-WTW PIPELINE (2.6 m diameter)				
General				
Excavation	m	5,600	280	20.0
Pipe Manufacturing and Supply	m	5,600	700	8.0
Construction incl. testing of pipes	m	5,600	280	20.0
LANGA DAM BI-DIRECTIONAL TAKE-OFF PIPELINE (1.6 m diameter)				
General				
Excavation	m	1,300	260	5.0
Pipe Manufacturing and Supply	m	1,300	650	2.0
Construction incl. testing of pipes	m	1,300	260	5.0
LANGA BALANCING DAM				
General				
River Diversion through Bottom Outlet Conduits	No.	1	0.10	10.0
Commencement of Impoundment	No.	1	0.13	8.0
Diversion Conduits				
Excavation of Bottom Outlet Portal	m^3	15,000	10,000	1.5
Coffer Dams				
Cofferdam 1	m^3	11,600	2,000	5.8
Cofferdam 2	m^3	1,700	1,500	1.1



Activity	Unit	Quantity	Rate/month	Months
Time (years)				
Time (Months)				
Time (Month numbers)				
Main Dam Embankment (CFRD)				
Curtain Grouting	m	8,060	1,000	8.1
Rockfill, incl. protection layers	m^3	1,628,200	100,000	16.3
Concrete Face	m^3	15,920	1,000	15.9
Spillway				
Excavation	m^3	2,530	110,000	0.02
Structures	m^3	365	3,300	0.1
LANGA BALANCING DAM				
Outlets				
Bottom Outlet	m	470	250	1.9
Intake Structure	m	47	1.50	31.3
Access Roads				
Access Road to Tunnel Outlet Portal and LBD (Option 2)	km	4.69	2	2.3
Access Road to WTP	km	2.37	2	1.2
Finishing and Rehabilitation of Site				
Rehabilitation of Site	No.	1	0.50	2.0
GAUGING WEIRS				
General				
Weir DS of Impendle Dam (Weir 1)	m^3	5,870	1,000	5.9
Weir DS of Smithfield Dam (Weir 2)	m^3	1,600	500	3.2
Weir DS of Smithfield Dam near Hella Hella (Weir 3)	m^3	6,260	1,000	6.3
Access Roads				
Access Road to Gauging Weir 1	km	0.17	2	0.1
Access Road to Gauging Weir 2	km	2.17	2	1.1
Access Road to Gauging Weir 3	km	2.52	2	1.3



AGREEMENT

APPENDIX 8: TECHNICAL GUIDELINES FOR DEVELOPMENT OF WATER AND SANITATION INFRASTRUCTURE

DEPARTMENT OF WATER AFFAIRS AND FORESTRY

TECHNICAL GUIDELINES FOR THE DEVELOPMENT OF WATER AND SANITATION INFRASTRUCTURE

SECOND EDITION: 2004

PREFACE

The first version of these Guidelines was issued in 1999. The original guidelines were specifically developed to give technical guidance to engineering and other experts who were responsible for developing RDP type water supply projects on behalf of the Department of Water Affairs and Forestry.

There have however been a number of fundamental changes since 1999, which prompted the Department to update the guidelines.

Firstly, a greater emphasis has been placed on the provision of basic sanitation services, necessitating the inclusion of guidelines on basic sanitation infrastructure.

Secondly, Government funding for water services is now channelled directly to Local Government through the Municipal Infrastructure Grant. With few exceptions, municipalities will in future be the main developers of basic services infrastructure.

Thirdly, much experience has in the interim been gained in the development of water services infrastructure and these lessons needed to be captured in the guidelines.

Finally, the adoption of the Strategic Framework for Water Services has impacted on the definition of basic services and on the approach to developing these services.

The purpose of this updated 2004 version of the guidelines is primarily to pass on the experience of national government in the development of water and sanitation services, and especially the planning and design of water and sanitation infrastructure, to local government. It is believed that this document will accelerate the learning process of those in local government who are taking full responsibility for water services development for the first time. It is also believed that these guidelines will be just as useful to those who wish to refine their existing knowledge.

While these guidelines are mainly technical in nature, the wider issues such as the social aspects and the operation and maintenance of water services infrastructure will be addressed in other documents.

A large number of experts from the Department of Water Affairs and Forestry and other organisations have selflessly contributed their experience towards the development of these guidelines. It is acknowledged that these guidelines would not have been possible without their contribution.

TABLE OF CONTENTS

COMMONLY USED ABBREVIATIONS

CD	Compact disk
DBSA	Development Bank of Southern Africa
IDP	Integrated development plan
DPLG	Department of Provincial and Local Government
DWAF	Department of Water Affairs and Forestry
LG	Local government
MIU	Municipal Infrastructure Unit
SANS	South African National Standards
SABS	South African Bureau of Standards
SFWS	Strategic Framework for Water Services
WSA	Water services authority
WSDP	Water services development plan
WSP	Water services provider

1 INTRODUCTION

Municipalities have a Constitutional responsibility for providing sustainable and viable water services to the communities within their areas of jurisdiction.

The purpose of these guidelines is to assist municipalities undertake the development of water and sanitation infrastructure, with a focus on the design aspects of development.

Further guidelines are in the process of being developed for Water Services Development Plans, social aspects and operation and maintenance of water services projects.

1.1 Purpose of guidelines

It is important to note that these guidelines:

- ARE MERELY INTENDED TO GIVE GUIDANCE TO MUNICIPAL OFFICIALS, PLANNERS AND DESIGNERS.
- Are not intended to replace professional expertise and engineering judgement.
- Provide overarching guidance and cannot be used as a replacement for specifications.
- Must be used together with recognised standards, codes, and acts such as those of the South African Bureau of Standards (SANS Codes), the Water Services Act, the National Water Act, and the Occupational Health and Safety Act.

These guidelines are made available through two media:

- A CD has been distributed which contains this document as well as a number of useful folders. The contents of the folders are listed at the end of this document.
- A downloadable version of the document is also accessible from the web page of the Department of Water Affairs and Forestry. The DWAF web page also contains the same folders that are included on the CD.

1.2 Definitions of minimum norms and standards

The aim of Water Services projects funded out of government grants is primarily to provide a basic level of water services.

Section 6 of the "Strategic Framework for Water Services" provides the minimum technical norms and standards for water services. The Strategic Framework is included in the ***Legislation and Policy Folder***.

The following definitions and minimum standards are given in the Strategic Framework:

Basic water supply facility is:
The infrastructure necessary to supply 25 litres of potable water per person per day supplied within 200 metres of a household and with a minimum flow of 10 litres per minute (in the case of communal water points) or 6 000 litres of potable water supplied per formal connection per month (in the case of yard or house connections).

Basic water supply service is:
The provision of a basic water supply facility, the sustainable operation of the facility (available for at least 350 days per year and not interrupted for more than 48 consecutive hours per incident) and the communication of good water-use, hygiene and related practices.

Basic sanitation facility is:
The infrastructure necessary to provide a sanitation facility which is safe, reliable, private, protected from the weather and ventilated, keeps smells to the minimum, is easy to keep clean, minimises the risk of the spread of sanitation-related diseases by facilitating the appropriate control of disease carrying flies and pests, and enables safe and appropriate treatment and/or removal of human waste and wastewater in an environmentally sound manner.

Basic sanitation service is:
The provision of a basic sanitation facility which is easily accessible to a household, the sustainable operation of the facility, including the safe removal of human waste and wastewater from the premises where this is appropriate and necessary, and the communication of good sanitation, hygiene and related practices.

Potable water quality is:
Water supplied by water services providers intended to be used for drinking or domestic purposes (potable water) must be of a quality consistent with SANS 241 (Specifications for Drinking Water), as may be amended from time to time.

Metering and flow control:
All unrestricted water connections must be metered or controlled to a basic level. Where appropriate, water services providers should consider the benefits of offering households controlled flow connections (for example, yard tanks) that can provide a basic supply of water cost-effectively. Where pre-payment meters are installed, these must take into account the free basic water services policy and allow for access to a basic amount of water at zero tariff.

Eradication of bucket toilets:
The bucket system is an unsuitable and inappropriate level of service. All water services authorities must identify and implement programmes for the eradication of all bucket systems by 2006.

1.3 Project development life cycle

A typical project development life cycle consists of the following phases:

Establishment of institutional arrangements

The designated municipality is the water services authority and is responsible for water services provision. The water services authority either contracts with a water services provider or fulfils that function itself.

Planning phase

The municipality:

- prepares a Water Services Development Plan (WSDP) as part of its Integrated Development Plan (IDP) for the area of jurisdiction of the Water Services Authority (WSA);
- undertakes Feasibility Studies for each water or sanitation project identified in the WSDP.

DWAF integrates all WSDPs into a National Reference Framework.

Design phase

The municipality procures the design consultant who designs the works and prepares the tender documentation or the municipality does it in house.

Tender stage

Advertising, site inspection, adjudication of tenders received and award of contract.

Construction phase

Execution of the works in accordance with the tender documentation under supervision

Operations and maintenance

The Water Services Provider operates and maintains the works (with or without the assistance of contractors) and collects the revenue.

The Water Services Authority (WSA) monitors the Water Services Provider (WSP) and manages the contract that it has with the WSP.

The WSA undertakes an annual water services audit and reports to DWAF who performs the function of Regulator.

2 LEGISLATION AND POLICY

A number of important statutes and policy documents govern the development and operation of community water supply schemes. Legislation affects all phases of development, and for example stipulates requirements for taking water from the resource, for the planning of water services, how to determine institutional arrangements, and the requirements for financial and other reporting.

The most important legislation and policy documents governing the development and operation of water services are:

- Constitution of the Republic of South Africa, 1996 (Act 108 of 1996)
- Water Services Act, 1997 (Act 108 of 1997)
- National Water Act, 1998 (Act 36 of 1998)
- Municipal Systems Act, 2000 (Act 32 of 2000)
- Municipal Structures Act, 2000 (Act 33 of 2000)
- Public Finance Management Act, 1999 (Act 1 of 1999)
- Local Government Municipal Finance Management Act, 2003 (Act 56 of 2003)
- Division of Revenue Act-Enacted Annually
- Strategic Framework for Water Services, September 2003
- White Paper on Sanitation, September 2001
- Regulations under S9 of the Water Services Act, 1997
- Regulations under S10 of the Water Services Act, 1997
- Regulations under S 19 of the Water Services Act, 1997
- Model Water Services Bylaws. Section 21(1) of the Water Services Act, 1997
- Guidelines For Human Settlements Planning and Design (Red Book). Obtainable from the CSIR.

The full text of these documents, with the exception of the Red Book, are included in the ***Legislation and Policy folder*** of the guidelines CD. Most of these documents must be read with Acrobat Reader which is available on the Web

Specific sections of these documents will also be highlighted in the different sections of the Guidelines.

3 INSTITUTIONAL ARRANGEMENTS

3.1 Introduction

The following institutions are responsible for the supply of water and sanitation services:

- The Water Services Authority;
- The Water Services Provider (Sometimes a Water Board or bulk water provider); and
- The Department of Water Affairs and Forestry as regulator.

Other National Government Departments also fulfil important roles. For example DPLG manages the Municipal Infrastructure Grant and the Equitable Share and the Department of Health has an important function regarding health and hygiene and sanitation.

A Water Services Authority (WSA) is the municipality that has been designated responsibility for ensuring access to water services. The WSA is both the owner of the works and is the elected representative of the customers.

A water services provider (WSP) is the person or organization that actually provides water services to consumers or to another water services institution. The WSA can either appoint a WSP, for example another municipality, a water board or a private contractor, or can fulfil the function itself.

3.2 Deciding on and contracting with a water services provider

The WSA should follow the procedure set out in S78 of the Municipal Systems Act when deciding whether it should fulfil the WSP function itself or whether it should contract with a separate WSP. A model Terms of Reference for a S78 Assessment has been developed by the Municipal Infrastructure Unit (MIU) which is associated with DBSA. This model Terms of Reference is included in the Institutional Folder.

S19 of the Water Services Act sets out requirements that must be complied with when a WSA contracts with a WSP. The Minister has promulgated regulations under S19 of the Water Services Act which sets out the minimum requirements with which a contract between a WSA and a WSP must comply. These regulations are included in the ***Legislation and Policy Folder***.

Even if the WSA fulfils the WSP function itself, it should account separately for water services, i.e. it should:

- keep separate financial accounts of how much was spent on or invested in water services during each financial year;
- the revenue it received from the sale of water services;
- funds received from National Government and other sources that were allocated to water services etc.

Water Services includes both water supply and sanitation services.

3.3 Bylaws and other requirements

S21 of the Water Services Act requires that WSAs must make bylaws which contain conditions for water services. Model Bylaws that comply with the requirements of S21 of the Water Services Act are included in the ***Legislative and Policy Folder***.

4 PLANNING

4.1 Introduction

Water and sanitation projects are essentially planned at three levels:

- At the national level the Department of Water Affairs and Forestry (DWAF) maintains a national reference framework;
- At a municipal level each Water Services Authority (WSA) compiles and regularly updates a Water Services Development Plan (WSDP); and
- At a project level each WSA undertakes a feasibility study for each project and compiles a technical report.

This hierarchy of plans are discussed below:

4.2 National reference plan

The Department of Water Affairs and Forestry is required to comment on the Water Services Development Plans (WSDP) of each WSA and to ensure that all current and projected activities are compatible with the national strategies. To enable a common framework for assessing WSDPs, a National Reference Plan is being developed which will capture the essence of each WSDP in one common structure that relates water services planning to the National Water Resource Strategy, Catchment Management Strategies (together with water allocations and licensing), Provincial Strategies and IDPs.

The reference framework will cover the following topics:

- General (Locality map and Demographics);
- Physical & Socio-Economic Development;
- Water resource availability, allocation and licensing;
- Service Level Development;
- Water Resource Development;
- Water Conservation & Demand Management;
- Water Services Infrastructure;
- Water Services Authority Institutional Arrangement;
- Customer Services;
- Financial Profile; and
- Project Development.

Municipalities will need to cross reference their plans to the National Reference Framework in order to integrate their own planning with other developments being undertaken in surrounding areas.

4.3 Water services development plan

Sections 12 to 18 of the Water Services Act, 1997 requires a Water Services Authority to prepare a Water Services Development Plan. These sections describe how to develop and adopt a WSDP and sets out the contents of the WSDP.

The Water Services Act, 1997 is included in the ***Legislation and Policy Folder***.

Whilst the WSDP is a legal requirement, the real value of preparing a WSDP lies in the development of a plan whereby the key municipal water services targets are set for a five year period.

The WSDP forms a subset of, and must be aligned to, the municipality's Integrated Development Plan (IDP).

The Department of Water Affairs and Forestry has prepared a set of Guidelines for preparing a WSDP. These Guidelines provide basic information about the WSDP, as well as specific information on how to prepare the WSDP.

The DWAF WSDP guidelines are included in the ***Planning Folder***.

4.4 Feasibility studies and technical reports

The aim of Water Services projects funded by municipalities out of government grants is primarily to provide a basic level of services to the poorer residents of the municipality.

Previously, project level business plans were compiled by municipalities for purposes of project approval and allocation of funds by national government. Under the Municipal Infrastructure Grant (MIG) it is no longer necessary for municipalities to submit business plans to National Government for approval. However municipalities are still required to plan for projects (feasibility studies) and to submit a Water Services Project Technical Report to the appropriate DWAF Office for recommendation before releasing funds for water services projects. It is recommended that the same approach be followed for all Water Services projects.

Essentially the Water Services Project Technical Report (Technical Report) comprises a description of the following elements of the project:

- Population
- Water consumption
- Existing works
- Water source
- Proposed works
- Supply pipelines and pump systems

- Service reservoirs
- Water purification works
- Distribution network
- Estimated cost of integral parts
- Unit cost of water
- Viability, acceptability and sustainability of proposed project
- Legal requirements

The format of the "Water Services Project Technical Report" is shown in the table below:

FORMAT OF WATER SERVICES PROJECT TECHNICAL REPORT

1.1	Introduction	(a) Name the engineering reports from which the report was compiled. Relevant letters or notes should be enclosed. (b) General A good concise description of the location of the local community or supply area based on its geographical location and main routes serving the area. The socio-economic activities of the community with much emphasis on the development prospects that can be realistically expected of the area as well as the climatic factors and their influence on the water consumption. (c) General nature and extent of the problem with regard to the water supply.
1.2	Existing works	A concise description of the existing works in which the relevant storage capacities, yield capacities, distances and heights are reflected and preferably it should be further illustrated by means of a site map or a diagrammatic sketch plan. In respect of the particular component of the works that has to be improved, more detail should be included, whereas more general detail on the remaining elements will suffice although the extent, condition and effectiveness thereof should be indicated. Briefly, the extent of the works is as follows:
1.2.1	Existing Water source	(a) From own sources, e.g. boreholes, reservoirs and/or abstraction from public

		streams. General detail, relative location, method of abstraction or supply, existing yield capacity, water rights, etc. (b) From other sources, e.g. Government water works, common works, or supply by water boards.
1.2.2	Existing Supply pipelines and pump systems	A general description, diameter, length and yield capacity of pipelines and pump units and, where applicable, number of pump units, pump heads, etc.
1.2.3	Existing Service reservoirs	Location, volume, condition and expected useful life and adequacy.
1.2.4	Existing Water purification works	General dimensions, type of treatment, yield capacity and adequacy.
1.2.5	Existing Distribution network	• General dimensions, condition and adequacy. • Is total use being metered? • Is every point of supply equipped with a meter? • Is the bulk supply to the different communities being metered? • How is water supplied to the different communities? • Stand-up taps or indoors? • Is there a water-borne sewerage system in these communities? • Are such improvements being planned for the future and, if so, for when? • How much is the unaccounted water?
1.3	Population	An estimate of the population growth over the next 25 years in stages of five years, showing the population to be provided out of the existing works and the population to be provided out of the proposed works. This estimate should be approached cautiously taking into account all pertinent factors, in comparison with the historical growth and accompanying socio-economic circumstances. Unless there are specific circumstances demanding elucidation, any estimate of the population growth is assumed to link up with the available census information.

		Where available the official information for the past 25 years for the supply area of the water scheme should be provided. If the supply area varies from the census area or if the census returns do not correspond with the area's own surveys, the latter figures should also be provided. If no figures are available a judicial estimate should be made of the present population, based on known items such as number of houses, etc.
1.4	Water consumption	The conditions and particulars of the water consumption over at least the preceding five years should be provided. In some areas records covering longer periods are available and it is useful to provide this information in such instances. The projection of the expected water needs should be compiled from various parameters that have an effect on the water consumption, e.g.: (a) Historical water consumption; (b) the unit consumption; (c) population projection; (d) water consumption of the business centre; (e) water consumption of the industrial area; (f) schools, hostels, old age homes, army complex, etc.; (g) municipal consumption, e.g. irrigation of sports grounds, parks, etc.; (h) unmetered use; (i) losses. If the losses in a system are higher than say 10%, an accurate loss analysis ought to be done on the system; and (j) climatic factors. In item (b) attention should also be given to the expected increase in unit consumption taking place as a result of the improvement in living standards. The estimates of the future water needs should be calculated in stages of five years over the next 25 years, and where applicable the expected peak consumption should also be shown. An example of a table that can be used in calculating the projected future water consumptions is given below.
1.5	Water source	A general description of the source, in addition to the description given in paragraph 1.2.1 above, indicating the adequacy of the source to meet the

		expected future water consumption. If the source is a storage dam or if one is being developed, the basic data of the dam should be furnished, i.e. the assured yield, mean annual runoff, size of catchment area and storage capacity of the dam basin. If available, information on the silting up should be included. In respect of boreholes the dependable yield of the various sources should be provided and for existing boreholes their performance during dry periods should be mentioned. Where water sources are shared with other consumers, the apportionment, water rights, agreements, permits, water court orders, servitudes, tariffs, etc. should be fully set out. Where the water source is being further developed, proper hydrological and/or geohydrological reports should be compiled. For new schemes the necessary permits, water court orders, servitudes etc. should be obtained. The quality of the water should be given as well as any process that will be used to treat the water should be commented on.
1.6	Proposed works	In the introductory paragraph a concise explanation should be given of the reasons for deciding on the water scheme or works in question. Where applicable it should be done on the basis of information obtained from an economic study or evaluation of alternatives weighed up against each other. The reader should be convinced that the proposed works represent the most favourable alternative and that works must indeed now be constructed. Further phases (say for the next 10 to 20 years) should be stated briefly so that a complete view of the future planning may be formed. Further, the individual components of the scheme should be described to provide at least the following information: (i) Description and dimensions: Volume, yield capacity, diameter, length, pumping head, pump yield

		capacity, pump drive requirement. (ii) Serviceability of proposed components in respect of the required rendering of service, i.e. to what extent future demands will be met. (iii) In respect of water feeder systems the peak capacities of the feeder pipes and water purification works should be mentioned. As regards distribution systems the maximum and minimum pressures in the network during zero and peak consumption should be furnished.
1.7	Integral parts and estimated cost	In this paragraph the engineer should give a capital cost estimate of the proposed scheme as accurately as possible. The term "integral parts" relates to those components of the scheme that can function independently, e.g. pipelines, pumping station, reservoirs, purification works, powerlines, dams, pressure towers, etc.
1.8	Operation and maintenance arrangement	It is important that arrangements for the operation and management of the works are dealt with before the project is completed. The designer of the project should provide the operating authority with an operating manual, in advance, in order for it to train or appoint qualified personnel to operate and maintain the project.
1.9	Viability	Calculations to show that the operations and maintenance are financially sustainable through a mix of tariff revenue and equitable share and other allocations.
1.10	Legal Requirements	Legal requirements that need to be complied with including water use licensing and Environmental Impact Assessments.

Example of a table for cost estimation:

ITEM	DESCRIPTION	COST (R)
1.	Concrete reservoir 1 000 m^3	.....
2.	Pumping station	.....
2.1	Pumping gear 2 x 55 kW x 35 l/s @ 65 m	.....
2.2	Pump house (50 m^2)	.....
2.3	Electricity supply KVA x L meter	.....
3.	Main supply pipeline (35 l/s)	.....
3.1	8 000 m x 250 mm dia	.....
3.2	4 000 m x 200 mm dia	.....
	Subtotal	_____
	10% contingencies	.....
	Professional fees and supervision	.....
	Subtotal	
	Total estimated cost	_____
	VAT	.....
	Total cost of scheme	_____

2. UNIT COST OF WATER

The total annual expenditure on completed scheme must be calculated in terms of the present cost.

An example on calculating the unit cost is given below.

EXAMPLE OF A TABLE THAT CAN BE USED IN CALCULATING THE PROJECTED FUTURE WATER CONSUMPTION

YEAR	HOUSEHOLD			INDUS-TRIAL	INSTITUTION SCHOOLS HOSP. ECT.	MUNICIPAL AND LOSSES	TOTAL CONSUMPTION		AVERAGE DAILY PEAK DEMAND	GROWTH RATE
	NUMBER	AVERAGE DAILY CONSUMPTION					DAY	YEAR		
		l/c	m^3/d	m^3/d	m^3/d	m^3/d	m^3/d	m^3/d	m^3/d	%/a

A. PRECEDING WATER CONSUMPTION (A record of at least the preceding 5 years ought to be provided.)

The actual annual water consumption for the previous 5 years should be shown to provide an indication of the historical growth rate. Sometimes these particulars are simply not available. A grouping of available data of actual water consumption according to group consumption and the determination of actual unit consumption of the various population groups, present the possibility to do more accurate projections of future water consumption. If bulk water meters are not available, summation of sales can be integrated with the general monthly bookkeeping. With modern accounting equipment it can probably be readily integrated.

B. PROJECTION OF FUTURE WATER CONSUMPTION

The method of calculation and assumptions on expected consumption should be motivated and should be compatible with the WSDP. The Departmental standards indicate the minimum standard to which consumption for institutions, etc., should be added. Some estimates assume larger unit consumptions per capita, whether as a result of gardening, high living standards, climatic conditions or because a separate estimate is not included for schools, hospitals and businesses etc.

The format of this example allows for gradual adjustment of unit consumption which mainly applies where improved services and exalted living standards eg. as a result of future indoors water supply and sewerage. Rainfall and climate information, nature of population composition and the economic activities (e.g. wet industries) of the community therefore should be elucidated in the report.

EXAMPLE OF A TABLE TO CALCULATE THE ANNUAL COST:

ITEM	DESCRIPTION	COST (R)
1.	Interest and redemption	
1.1	Existing works	
1.2	Proposed works R x A% p.a. for 25 years	
2.	Maintenance cost	
2.1	Existing works	
2.2	Proposed works	
2.2.1	4% on mechanical equipment to the value of	
2.2.2	1% on pipelines and powerlines to the value of	
2.2.3	0,5% on civil works to the value of	
3.	Electricity cost E kWh @ B c/kWh	
4.	Chemicals Z m3 @ C c/m3	
5.	Salaries and wages of operating staff required i.t.o. section 12A of the Water Act	
6.	Administrative costs @ RD per point of connection	
	TOTAL ANNUAL COST	
	Based on the estimated annual water consumption the unit of water is	x c/m3

NOTES:

(A) Interest rate at time of application for funds.

(B) Cost of electricity per unit.

(C) Cost of chemicals per m3 (kl).

(D) The actual estimated administrative cost.

(E) Total units estimated to be used.

(Z) Estimated water consumption plus losses.

5 DESIGN CRITERIA

5.1 Introduction

These planning/design criteria have been determined to provide a basic level of water supply with some provision has been made for the future upgrading of the supply to higher levels of service. For higher levels of service the Red Book should be used.

Not withstanding the guidelines given in this document, the professional responsibility for selecting appropriate planning/design criteria for the specific circumstances remains with the planner or design engineer.

5.2 Summary of design and planning criteria

Recommended planning/design criteria are summarised in the following table:

GENERAL SUMMARY OF BASIC PLANNING AND DESIGN CRITERIA

1	Design Horizon:	10 Years from commissioning for pipelines and reticulation. 5 - 10 years for all above ground civil works and mechanical and electrical equipment.
2	Population:	For Design Horizon as above.
3	House occupancy:	6 persons (unless evidence exists to prove otherwise).
4	Growth Rate: (up to Design Horizon)	As projected in WSDP or otherwise proved. Could be as low as 0% in some areas.
5	Design Water Usage:	60 lcd for all infrastructure components In cases of restricted groundwater sources, a minimum water usage of 25 lcd is acceptable for pumps, pumping mains and elevated tanks only. Even in cases of restricted groundwater sources reticulation is to be designed for 60 lcd.
6	Design Loss Factors (LF):	i) Water treatment works, LF_w = 10% ii) Total conveyance losses, LF_r = 10%
7	Gross Average Annual Daily Demand (GAADD):	$GAADD = (1 + LF_r) * AADD$
8	Summer Peak Factor:	SPF = 1,2 minimum to 1,5 maximum
9	Summer Daily Demand, WATER TREATMENT WORKS AND	$SDD_{ww} = SPF * GAADD * (1 + LF_w)$ Design Pumping Period = 20 hrs/day

	RAW WATER AND CLEAN WATER PUMPS, (SDD_{ww}):	
10	Summer Daily Demand, BULK SUPPLY PIPELINES, (SDD_{pl}):	SDD_{pl} = SPF * GAADD
11	Summer Daily Demand, BOREHOLE PUMPS, (SDD_{pu})	SDD_{pu} = SPF * GAADD Design Pumping Period – See below
12	Storage Reservoirs: (Total Storage, i.e. Regional and Village Reservoirs combined, but excluding elevated tank volume)	48 Hrs * AADD Pumped from One Source 36 Hrs * AADD Pumped from Multiple Sources 24 Hrs * AADD Gravity Source Recommended to split volumes roughly equal between Regional and Village storage's for new reservoirs. A maximum of 24 hours and a minimum of 16 hours is required at Village storage. Reinforced concrete structures only acceptable. Exceptions apply for a groundwater source supply where a ground level storage is inappropriate. In this case an elevated tank with 16hrs (for 2 or more powered borehole pumps) to 24hrs * AADD (one powered pump only) for 25 lcd is acceptable**.**
13	Elevated Tank/Tower: (Only required to provide reticulation pressures)	4 Hrs * AADD (only for area to be served by tank) Max. 6 x 10 kl for polyethylene tanks on stands. From 75 kl and greater size use pressed sectional steel tanks on stand.
14	Design for pipeline flow between Main Storage and Elevated Tank:	2 * GAADD (Gravity) 2 * GAADD (Pumped: 20hrs/day)
15	Design Peak Factor (for Reticulations):	DPF = 2 to 3
16	Design Peak Flow Rate (DPFR for Reticulation):	DPFR = DPF * GAADD Primary reticulation designed to supply 60 lcd for all erven, but only standpipes and existing erf connections to be provided against project costs. New erf connection piping to be paid for by the new consumer.
17	Standpipe design: Flow Rate	DPFR divided by No. of standpipes, subject to a minimum of 10 1/min (0,17l/s) per tap Note: Standpipe with two taps – flow rate 20 l/min
18	Standpipe design: Spacing	Each household must be within a 200m radius of a Standpipe Note: Additional standpipes should be provided if a

		physical barrier, such as a river, main highway, railway or long housing block unduly lengthens the walking distance to standpipes.
19	Residual Pressures (above GL):	10 m minimum at point of delivery, where possible. *Flow limiters must be installed on stand pipes when Residual Pressure are greater than 25 m above GL.*

5.3 Water availability

A common cause of scheme failure is the overestimation of the availability of water. Care must be taken that the underlying assumptions of water source availability are proven, especially in the case of ground water and where river abstraction is not controlled by significant upstream storage.

5.4 Power availability and alternative pump drives

It is also important that the availability of a power supply for the project is properly investigated. Installation of long power lines may prove to be very expensive. Dedicated transformer supply points are preferred.

In some instances an economic Eskom power supply may not be available, in which case alternative power sources for driving pumps must be considered. There are many factors to be considered in these instances and it will be up to the engineer to investigate these factors. Some of the factors to be considered are:

- Amount of power required.
- Can this be provided by solar means - usually for small power requirements.
- Can the pumps be directly driven by a diesel engine.
- Can a diesel generator be provided in anticipation of later conversion to Eskom power supply.
- Are facilities for operation and maintenance of diesel engines available,
- The comparable cost of each solution.

5.5 Guidelines for economic optimisation of pump - pipeline sizing

Two or three of the preferred layouts should be compared in terms of cost, technical feasibility, economic viability, social and environmental impacts.

5.5.1 Economic analyses

At the preliminary design stage, economic analyses will normally only be undertaken for surface water pumping mains. The purpose is to optimise the pump and pipeline sizes by comparing the net present value of alternative configurations.

These analyses are not usually relevant for small village pumping mains from localised boreholes.

Usually the analysis compares net present values over a planning horizon of 30 years.

The recommended criteria to be used for economic analysis of water supply infrastructure are as follows:

(i) Infrastructure Lifetime:

Small pumps and motors	15 years
Electric installation	15 years
Structures and buildings	30 years
Pipelines	30 years

(ii) Power Costs: Eskom Tariff A

(iii) Operation and Maintenance Costs:

Pump station: 0,5 % per annum (p.a.) of total pipeline costs
0,25 % p.a. of pump station civil costs
4 % p.a. of pump station mechanical and electrical costs

Pipeline: 0,5 % p.a. of total costs

Civil Works: 0.25 % p.a. of total costs

(iv) Discount Rates:

8% p.a. or the official Government discount rate as revised from time to time (but sensitivity analysis also done to test for 6 % and 10 %)

5.5.2 Pump and pipe sizing for small borehole schemes

In most cases the boreholes for small schemes have yields of less then 5l/sec and only require a pumping main of one to two kilometres to the village storage or reticulation.

Typically, pipe diameters are less than 100mm. Pumps for borehole schemes are also usually small, typically less than 10 kW.

Sizing of pipes, and therefore pumps, can normally be made using simple engineering calculations without the need for undertaking optimisation analyses.

Simple guidelines for this type of scheme are:

(i) Pipeline velocities of between 0,8 and 1,0 m/s generally result in optimised pump and pipeline size.

(ii) For diesel engine powered pumps the optimum pump and pipeline should be governed by the option with the lowest recurrent diesel fuel consumption.

6 DESIGN REPORT, DRAWINGS AND SPECIFICATIONS

6.1 Introduction

This section deals with the design report and the design drawings.

A typical water supply scheme comprises the following components:

- A source, which could be boreholes or a dam or a weir;
- A water treatment plans;
- A pumps station;
- Pipelines;
- Reservoirs; and
- Consumer connections.

The design of all of these components are discussed in following sections.

A section has also been included on VIP Pit Latrines.

6.2 Design report

Design reports should generally contain the following information:

- Cover page (Region/Province's name, District Council/Water Services Authority, Consultant's name, Scheme name, CWSS No. Locality number, File No., Date, and report's status, i.e. draft 1, draft 2 etc.).
- Index/Contents page.
- Executive summary.
- Description of the project. Refer to locality and scheme layout plans, preferably in A3 size.
- Historical background – for existing supply.
- Statistical data.
- Design philosophy.
- Water source - to be correctly and thoroughly described as described below.
- Design assumptions.
- Sizing of components/infrastructure (litres per second or m^3) - clearly indicate how sized. Peak factors should be motivated.
- Discussion of alternatives and choice of preferred solution.
- Design standards – SANS, BS, etc. standards used to design each component.

- Special problems and their solution.
- Methods of analysis.
- Geology.
- Foundation treatment.
- Diversion.
- Instrumentation/ Scheme's control system.
- Quantities.
- Costs including fees, contingencies and VAT and indicate schemes budgeted amount.
- Programme – bar chart in weeks/months.
- Recommendations.
- References - White papers, feasibility reports, previous and / or other phases design reports, etc.
- Annexures - not greater than A3 size containing a locality plan.

Usually 5 copies of each report will be required.

An expanded framework for the design report is included in the design folder.

6.3 Sustainability

Sustainability must be designed into the development process. At least the following should be confirmed (preferably in the Design Report) before going out to tender:

- Name of the identified WSP;
- Budgeted Operation and Maintenance costs;
- Amount allocated for basic water supply;
- Cost recovery mechanisms and expected revenue;
- Other sources of operating funds (such as Equitable share).

6.4 Drawings

Drawings should generally comply with the following standards:

- All drawing work shall be done on A1, or smaller size sheets with the client's standard title block. All electrical drawings to be A3.
- The drawings remain the property of the Client.
- The minimum letter size is 3mm.
- All drawings shall be signed by the employer or his representative.
- Alterations to drawings may only be authorised by the employer or his representative.
- Index drawing sheets of the complete scheme or part thereof as per type drawing, must be drawn up giving a list of all drawings with their description and must be subsidised in sections with appropriate section headings. Reference must be made on all drawings to these index drawing numbers.

- Every project shall have a compilation/ property diagram drawing(s), showing the required expropriation and/or servitude requirements for bulk water pipelines up to the revenue flow meter and associated dimensions.
- Cross sections on drawings shall be consecutively numbered for each part of the project. The number and section as well as the sheet number where the section is shown must be indicated on the drawing where the position of the section is shown, i.e. 49 section number 12 sheet number
- Pipeline drawings shall contain a summarised complete profile drawing(s) indicating the pipeline profile, design and field test pressure lines, pipeline and valves' major characteristics.
- Detailed profile drawings shall contain a plan view showing major topographical features, property boundaries and all other items as per DWS 1110 clause 4.1 (See Design Folder for Standard Specifications).
- Drawings prepared by the Consulting Engineer must bear a partners or directors signature.
- Drawings prepared by the Contractor must be thoroughly checked by the Consulting Engineer with particular regard to compatibility with proposed, adjoining or existing works.
- Manufacturers' drawings shall be supplied as specified in mechanical contracts and wiring and circuit diagrams shall be supplied as specified in electrical contracts.
- Where civil works are based on plant layout drawings prepared by the mechanical/electrical contractor, the drawings shall be formally approved by the mechanical/electrical representative of the employer, after which the layout may not be altered without repeating the procedure.
- On completion of the works the original drawings must be updated to the "AS BUILT" condition, clearly marked "AS BUILT" and all drawings returned to the employer or his representative for safekeeping in a format as specified. The original will be returned to the Consulting Engineer for his records. Submitted not later than 3 months after completion of the project.

Approval of the specification or drawing shall not absolve the Consulting Engineer of any responsibility.

6.5 Standard drawings

A number of standard drawings are included in the ***Drawings Folder***. CAD software is required to read these drawings.

6.6 Special drawing requirements and operating and maintenance manuals

Special requirements for drawings for tendering, manufacturing, and construction of a mechanical/electrical nature and special requirements for mechanical and electrical operating and maintenance manuals are included in the ***Design Folder***.

6.7 Design specifications

The following DWAF specifications are relevant to the design of Community Water Supply Schemes and are included in the ***Specifications Folder***. DWAF gives its approval to any municipality or water board to use or adapt, for their own purposes, any of these specifications:

NUMBER	DESCRIPTION
DWS 0510	Drilling and grouting
DWS 0750	Water retaining concrete
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
DWS1160	Design, manufacture, supply, and installation of Polyvinyl Chloride (PVC) Pressure Pipes and fittings
DWS 1710	Bricklaying
DWS 1720	Plasterer, tiler, and floorer
DWS 1730	Glazing and painting
DWS 1740	Plumbing
DWS 1810	Specialist services
DWS 1910	Supply, delivery, installation and commissioning of mechanical and electrical equipment for a bio-filter plant
DWS 1930	Supply, installation and commissioning of water treatment plant equipment
DWS 1940	Design, manufacture, supply, delivery, installation and commissioning of package water treatment plant
DWS 1950	Supply, installation and commissioning of a reverse osmosis unit for the desalination of mineralised water
DWS 2010	Boundary fencing
DWS 2410	Landscaping
DWS 2510	Valves (set of specifications)
DWS 9900	Corrosion protection (set of specifications)
DWS GTE	General Technical Specifications (Electrical)

7 BOREHOLES

7.1 Borehole development steps

The establishment of potable groundwater sources for community water supply entails hydrogeological related investigations and the drilling and test pumping of existing and new boreholes.

It is a requirement that the establishment of potable groundwater sources should be executed under the controlled supervision of qualified and suitably experienced hydrogeologists, (geologists, geophysicists and hydrogeological technicians).

The hydrogeological services required during project implementation are as follows:

- **Assessment of existing groundwater sources.** This may require the test pumping of existing boreholes, rehabilitation or re-drilling of boreholes, chemical analysis of water samples from existing boreholes and an examination of documentation relating to the reliability and sustained discharge rate of existing boreholes.

- **Groundwater quality assessment.** In areas with marginal water quality, testing of newly drilled boreholes or equipped existing boreholes should not commence prior to availability of chemical analysis results of TDS, NO_3 and F.

- **Borehole siting.** The hydrogeologist is responsible for ensuring that appropriate scientifically based methods are used to identify suitable drilling targets (sites) in accordance with hydrogeological conditions for exploration drilling. In order to ensure safe working conditions and to limit the risk of pollution entering the groundwater abstraction facility, borehole sites are also affected by the existence of manmade structures such as roads, pipelines, cemetries, sewage plants, overhead powerlines, buildings, etc.

- **Supervision of borehole drilling and administration of drilling contracts.** The hydrogeologist is responsible to ensure that boreholes are drilled, designed and constructed to the required standards by controlled and on site supervision of drilling rigs. One supervisor is to supervise at least two drilling rigs up to a maximum of three drilling rigs.

- **Supervision of borehole test pumping and administration of testing contracts**. The hydrogeologist is responsible to ensure that the required and appropriate calibration, multi-rate draw-down, constant discharge, and related recovery tests are conducted to the required standards by on site and controlled supervision of testing contractors.

- **Borehole yield recommendations.** Motorized borehole pumps are generally warranted only in instances where a discharge rate in excess of 0,5l/s can be maintained for a continuous pumping period of eight hours or more per day. Borehole yields must always be determined on the basis of 24 hour per day pumping.

- **Reporting.** A technical report documenting all data and information is required on completion of investigations. The project hydrogeologist is required to ensure that data requirements from the hydrogeologist and contractors are documented on appropriate data recording forms and submitted to DWAF.

- **Borehole development.** This comprises the removal of drilling fines from the aquifer pores, removal of drilling foam/mud and establishing a reverse filter around the borehole aquifer interface. Duration of development can vary from a couple of hours (formation stabilizer, hard rock formations) to several days (unconsolidated fine sandy aquifers). Boreholes must also be disinfected or sterilized of any bacteria, and particularly coliform bacteria, intruded into the borehole during drilling operations.

- **Borehole Protection and Marking**. The borehole is protected from foreign material by means of a lockable cap fitted to the borehole collar. The borehole should be marked with a pole (5 meters to the north of the borehole) of approximately 2,0 m high with a number plate, showing the borehole identification number.

- **Borehole pump testing.** The pump testing contractor is required to test newly drilled boreholes which have not yet been equipped and existing boreholes which may or may not already be equipped with pumping installations. The type of borehole test methods required include:
  Slug Test
  Calibration Discharge Test
  Stepped Discharge Test
  Constant Discharge Test
  Recovery Test

- **Monitoring the resource.** The geohydrologist must develop a monitoring system for at least one full hydrological year to evaluate the resource response to the safe yield abstraction rate. After this period the monitoring program should be re-assessed and planned according to prevailing climatic conditions.

7.2 Borehole pumps

The pump specified must not be capable of exceeding the safe yield of the borehole when utilized over a 24 hour period.

The rest and pumping water levels in a borehole may vary considerably during drought and above average rainfall sequences. Choice of type of borehole pumping plant must take this into account.

The selection of the particular pumping unit must also take into account the following factors:

- The static head between the lowest drawdown level anticipated in the borehole and the delivery point at the borehole top.
- The friction generated in this length of rising main given due attention to the presence of any operating rods within the rising main.
- The static and friction heads from the top of the borehole to the top water level of the delivery point.
- The ability of the pumping plant to commence operation under the full static head conditions of the pump unit.
- The ability of the pump to start operation with the riser pipe empty.
- The level at which the pumping unit has to be placed in the borehole must be as specified by the hydrogeologist or based on reliable information known to the engineer should a hydrogeologist not be available.

Borehole pumps can be powered by means of line supply electricity, solar power, or diesel power. It is generally not acceptable to provide motorised borehole pumps in boreholes yielding less that 0,5 litres per second.

7.3 Borehole monitoring and other equipment

All boreholes and borehole pumping plant must be provided with equipment to monitor pump, borehole and aquifer performance. The main components required are:

- Water meters
- Hour meters
- Water level depth measuring devices –a conduit pipe (20-25mm diameter) next to the riser in the borehole through which a measuring cable can be lowered is preferred, however an electrical transducer or pressure pipe is an alternative.
- Operational equipment

The following operational equipment is required:

- Non return valve, to prevent backflow into borehole.
- Isolating valve, to prevent backflow into the borehole. Only allowed for positive displacement pumps if a pressure relief valve is installed upstream of the valve.
- Scour valve.
- Valves placed to enable removal/replacement of meter in exceptional circumstances.
- Pressure release valve upstream of all isolating valves.

- Pressure cut out switch with manual control and pressure cut out switch with 1 to 2 hour timed reset in auto control (if electrically operated).
- Delivery pressure gauge.
- Low water level in borehole cut out relay with manual control and low water level in borehole cut out relay with 1 to 2 hr. timed reset in auto control (if electrically operated).

8 DAMS AND WEIRS

8.1 Dams

In some cases dams will be required to store surface runoff and to provide the bulk water supply source.

The size of the dam is dependent on the water demand, the required assurance of delivery, the hydrological characteristics of the river, and the characteristics of the dam basin.

The type of dam to be constructed will, amongst others, depend on site configuration (topography), foundation conditions and the availability of suitable construction materials.

8.2 Weirs

Where a dam is used for bulk water storage, and the water is released down the river, it may be necessary to construct a weir at the point of abstraction. The purpose of the weir is usually to provide limited balancing storage for the bulk releases from the dam.

Weirs can also be constructed to store limited amounts of runoff, or even, by allowing the basin to be filled with alluvial material, to create a reservoir within the alluvial sand from which water can be abstracted.

In the case of weirs, siltation is a far greater problem than in the case of large or medium sized dams. The outlet works and abstraction points of weirs need to be kept free of silt.

Weirs, generally being of a limited height and capacity, will also be overtopped by (large) floods. They will therefore need to be constructed of concrete or other non-erodable material.

A site for a weir, where both the riverbed and the abutments consist of good quality rock is an ideal situation. More usually the weir is founded on rock in the river section and one or both of the abutments will comprise of soft river-bank materials. In this case special measures are required to prevent outflanking of the structure by (large) floods.

8.3 Approved professional engineer

Dams are site specific. The Dam Safety Regulations may require that an Approved Professional Engineer (APE) assume responsibility for the design depending on the site, capacity, and hazard potential of the dam. The classification of a proposed dam is done by the Dam Safety Office of DWAF upon submission of an application listing the pertinent data.

Dams can be categorized into the following categories:

- Category I,
- Category II, and
- Category III.

The design of weirs should also be undertaken, or supervised, by competent engineers who are conversant with the particular problems associated with these structures.

8.4 Outlet works of dams and weirs

The outlet works of a typical dam comprises the following components:

- Outlet works;
- Outlet pipe systems
- Intake entrance
- Control valves for outlet works
- Isolating valves
- Control valves
- Intake isolating gates
- Under water wall mounted sluice gates
- Maintenance cranes
- Screening of intake works

The requirements for the outlet works of a typical Class I Dam is described below:

8.4.1 Depth of water draw off

Water drawn from the dam directly to the water treatment works should come from the upper 1,2m layer of the dam.

8.4.2 Outlet pipe systems

Dual system outlets should be provided in order to ensure continuous outlet from the water sources during repair or maintenance of the main outlet.

At the most upstream point of the outlet pipe system, an emergency closure by means of an underwater wall type spindle driven sluice gates operated by manual actuators may be employed only if the size of the outlet is in excess of 600 mm diameter.

8.4.3 Intake entrance

The most upstream exit from the dam/reservoir should consist of a bellmouth. Maintenance of bellmouths is practically impossible due to leakage through the isolating gate seals (if gates are employed) and limited working space downstream of such gates. Intake bellmouths and adjacent pipework should thus be fabricated from stainless steel up to the downstream isolating valve.

Should the pipework downstream of the isolating valve be built into concrete or buried in earth, this pipework should also be fabricated from stainless steel.

Accessible pipework in any outlet system i.e. pipes which are exposed and are removable, may be fabricated from mild steel and corrosion protected.

HDPE pipework is acceptable for small dams. Reducers and pipework directly adjacent to valves should be of fabricated steel.

The coupling of built-in steel or HDPE pipework should be SABS or BSS 4504 flanges only and should be rated according to the hydrostatic pressure of the outlet works. Flanges should normally be used to join built-in pipes. HDPE pipe may not be joined with friction grip couplings. Friction grip couplings are unacceptable in other cases as well except where construction joints occur.

Air supply pipes should be fitted to the outlet bellmouth top and extended to above the high flood level of the dam. The air pipe should be at least 1/6 th of the diameter of the outlet pipe.

8.4.4 Control valves for outlet works

8.4.4.1 Isolating valves

Pipe outlets should be provided with a valve downstream of the pipe entrance to facilitate maintenance of the control valves and downstream pipework. Pipe outlets up to 300 mm in diameter should be provided with open port resilient seal valve (RSV) type gate valves.

Rising and non-rising spindles are acceptable. Pipe outlets exceeding 300 mm diameter should be fitted with butterfly valves double flanged or wafer type having horizontal spindles only so as not to be affected by silt build-up on the bottom of the pipe. For small dams and weirs, manual actuation can be specified for all isolating valves. Manual operation is to be provided as far as possible due to the low cost and lower maintenance. Larger valves may be fitted with manually operated gearboxes to limit operating forces on the hand wheels or levers to 100 kN.

Isolating valves should all be situated in fully accessible boxed-out chambers having suitable drainage facilities.

Valves situated in chambers less than 1,8 m deep should be provided with extension spindles, which are operable from the deck of the chamber.

Valves in chambers more than 1,8m deep should be accessible via vertically mounted access ladders.

All isolating valves should be removable by means of either approved flange adapters or in line pipe couplings situated directly downstream of such valves.

Supports should be provided under pipework at either side of dismantling couplings, excepting in cases where such couplings are converted to thrust absorbing couplings by means of studs and thrust collars.

8.4.4.2 Control valves

Control valves are to be situated at the end of outlet works pipelines to facilitate controlled flow outlet from the dam.

resilient seal valve (RSV) type gate valves are acceptable control valves for small dams and shall as far as possible be manually operated.

In cases of free discharge into rivers, adequate protection must be given to the environment in the immediate vicinity of the valve to prevent erosion.

8.4.4.3 Control valves - needle type

Only in extreme instances where low head loss is important should in-line needle valves be used for controlled water outlet from the dam or weir.

Since needle valves are mounted in the pipeline, their energy dissipating qualities are not as effective as sleeve valves. It is thus advisable to either provide the pipe exit downstream of the valve with a flared disperser, which is to be shaped to cause a hydraulic jump or alternatively the exit should disperse into a stilling chamber.

Needle valves should be operated manually in the case of low head dams (12 meters maximum). It is essential to have a mechanical position indication in 10% increments on the handwheel headstock in order to facilitate accurate water outlet control in accordance with the flow chart provided with the valve.

Acceptable needle valves are more fully described in Standard Specification DWS 2510 - 1996.

8.4.4.4 Intake isolating gates

Dam outlet works having maintainable horizontally placed outlet pipework may be provided with emergency closure gates i.e., gates which are capable of closing under fully unbalanced condition and against high flood conditions (HFL).

Emergency closure is required for unforeseen simultaneous failure of the isolating valve and control valve or a failure in the pipework or pipe couplings downstream of the outlet entrance.

The construction and functioning of wall mounted sluice gates, which have positive spindle drives, are more fully described below.

Dam outlet works having vertically placed outlets may be isolated by means of a rubber lined steel sphere or tapered plug. These however only serve as service closure mechanisms i.e. to isolate pipe entrances under balanced hydrostatic conditions.

8.4.4.5 Under water wall mounted sluice gates

These gates are generally spindle driven units which are secured in a sealing frame where sufficient movement is provided upwards for the gate to clear the inlet fully open and for the downward stroke to seal off the opening completely.

These gates are primarily proprietary items provided by private concerns and are provided with either metal to metal sealing qualities or alternatively with rubber to metal seals. Departmental designs for such gates for operation under low head conditions are also available i.e. for water heads in the order of maximum of 6 meters. Wall mounted sluice gates are spindle driven units where the spindle is supported against buckling by means of wall mounted brackets, spaced to suit the design criteria.

Since these gates are permanently submerged all materials used should be of stainless steel. Exposed sealing frame components built into concrete should be stainless steel grade 316 or 316 L. The gate body should be of at least stainless steel 304 and 304 L. All fasteners should be of stainless steel.

Drive spindles should consist of stainless steel 304 or 304 L as well as submerged wall mounted spindle guide brackets. Wall bracket spindle guide sleeves should be of vescolene PP, ultrablack, or vesconite and should be split to facilitate removal of the gate spindle without having to remove the wall bracket in the process.

All fasteners for under water fixing of components to concrete should be of stainless steel.

All fasteners used on the assembly of the gate and sealing frame should similarly be of stainless steel.

Operating gear for wall mounted sluice gates should as far as possible be manually operated. The screwed spindle shall be stainless steel and should be driven through a brass nut by means of a handwheel mounted on a headstock. The headstock, which is to be mounted on the concrete deck of the outlet works, may be of mild steel fabrication (galvanised).

Rising spindle designs are essential since experience has proven that submerged drive nuts used on non-rising spindle designs renders the gate inoperable due to algae and other debri suspended in the water which enters the drive nut thread.

Rising spindle drives should be provided with position indicator in 10% increments from the fully open to fully closed stroke of the gate.

The indicator arrow should be driven by the spindle either within a slot in the headstock or in a column mounted on top of the headstock over the rising spindle. The manual operating force on the handwheel or cranking lever should not exceed 100 kN. Gearboxes may be employed to reduce operating forces to within the given limit. Handwheel diameters should not exceed 600 mm and lever arm radii should not exceed 400 mm.

8.4.5 Maintenance cranes

Affordable maintenance cranes in the form of slewing jib type, A-frame structures or monorail hoist structures should be provided for the handling i.e. installation and removal, of accessible mechanical components forming part of the outlet works of the dam such as valves and pipework. Removable manually operated hoist units should be employed as far as possible, which includes geared chain hoists, pneumatic chain hoists or winches. All hoist structures should be designed in accordance with BSS 2573, BSS 466 and should comply with the requirements of the Occupational Health and Safety Act.

Crane structures should provide sufficient approach to enable an operator to offload the equipment from a truck and to install such equipment with ease and visa versa. The structures should be of simple, affordable basic design and fabricated from galvanised mild steel.

Fasteners having key functions in the structural strength and stability of the structures should without exception, especially in respect of supporting carriage beams, monorails etc. be of stainless steel. Geared trolleys having manual drive chains to facilitate long or cross travel should be fitted to the carriage rails/beams. All crawl beams should have removable end stops to prevent over-travel of the trolleys and hoist units. To prevent deterioration of the hoist units due to outdoor exposure, they should be removed directly after each use and suitably stored for future use as may be required.

To prevent overloading of cranes, the safe working loads should be clearly displayed on the travel beams, hoist trolley as well as on the hoist or winch unit, example 1,5t SWL. Hoist units and winches as well as travelling trolleys are proprietary items.

Structures especially those of slewing jib cranes should be designed to ensure that minimum maintenance will be required and should incorporate self lubricating bronze or plastic bushing and sealed roller ball or thrust bearings. It is however essential to provide sufficient lubricating nipples at all strategic points of moving components.

8.4.6 Screening of intake works

In order to prevent debris from entering the outlet pipes of the dam from the upstream side and thus forming blockage of the isolating and especially the control valves, removable fine screens having clear openings between slats of 20 mm (min) to 25 mm (max) are to be provided and placed at a distance of 1,5 X pipe outlet diameter (minimum) from the intake pipe entrance. These screens are to be placed upstream of the emergency gate or wall sluice gate in all instances and should either be individually lowered in guides, one on top of the other by use of either an automatic grapple or by inter-linking the screen elements in cases where more frequent removal is required.

The screen size should be such that the water velocity through the slats does not exceed 2m per second.

The total height of the stacked screen units should extend from the very bottom outlet pipe up to at least 500mm above the high flood level (HFL) of the dam or weir.

9 WATER TREATMENT WORKS

9.1 General

As with dams, the design of the water treatment process is a specialist field of expertise and should be done by a suitably trained professional engineer.

Certain broad guidelines can however be given for planning purposes.

9.2 Potable water quality

Potable water should comply with SANS 241.

9.3 Selection of appropriate treatment process

The selection of an appropriate treatment process is essentially determined by:

- The raw water quality (physical and chemical).
- The prescribed final water quality.

9.4 Recommended loading rates and design parameters for water treatment process units

The following loading rates and design parameters can be given as guidelines only and should be tested against actual circumstances:

- Rapid mixing: at least 500mm head loss (mixing in G values, $G = 2000^{-5}$).
- Floculation: 10 min. Retention with a total head loss of about 150mm and $G = 50s^{-5}$ $(40 - 80)^{-5}$
- Horizontal flow settling tanks (in lieu of other flow types) are recommended for turbid raw waters > 200NTUs with manual sludge or hydraulic sludge withdrawal and a maximum loading rate of $1m^3/m^2.h$.
- Direct gravity filtration as secondary solid/liquid phase separation step: filtration rate 5m/h with upstream flow control.

- Upflow-downflow (series) filtration: only to be constructed when the raw water turbidity rarely exceeds 100NTU (say 5% of the time). Recommended filtration rates are:
    - Upflow: 5m/h
    - Downflow: 10m/h
- Flotation: recirculation rate of 10% and a loading rate of $6m^3/m^2.h$.
- Sludge and wash handling facilities: for design purposes assume that the sludge will thicken to a 10% concentration. The sludge dam should be large enough for a planning horizon of 6 to 8 years and space should be available for a second dam.
- Production losses through water plant: allow 3% to 5%.
- Chlorine contact time: 6% of flow capacity. 6% x 24 = 1,5 hours.
- Clear water sump for high lift pumps: 2% of flow capacity.
- Sludge disposal to sludge dams.
- Design flow capacity of plant to be based on the average daily summer demand plus 5% for production losses.

The sludge from settling (sedimentation) tanks should at least flow to sludge lagoons from where only the supernatant flows to rivers. Reclamation can be considered where water is scarce and supernatant can be used.

9.5 Automation

If a water treatment plant has more than 4 rapid gravity sand filters, the filter backwashing sequence may be automated. Other operations, for example chemical dosing and sludge withdrawal will only be automated in plants bigger than 50 000m3/d (579 litres per second).

Automation shall be motivated and not governed by hard and fast rules.

9.6 Structural considerations

It is recommended that all reinforced concrete water retaining structures should be designed to a 0,2mm crack width using 30MPa concrete in accordance with BS8007.

9.7 Accessibility

All units should be easily accessible, and easily removed for repairs. Walkways should be provided to give safe access to all points requiring inspection and to provide logical progression to operators doing inspections. Ease of handling chemicals should receive special attention.

9.8 Specifications

The following specifications are relevant for the design, manufacture, supply, construction, and commissioning of water treatment plants.

Departmental Specification	Description
DWS 1930	Supply, installation and commissioning of water treatment plant equipment.
DWS 1940	Design, manufacture, supply, delivery, installation, and commissioning of package water treatment plant.
DWS 1950	Supply, installation, and commissioning of a reverse osmosis unit for the desalination of mineralised water.

These specifications are included in the ***Specifications Folder***.

10 PUMP STATIONS

10.1 Introduction

Community water supply schemes are likely to involve the pumping of relatively small quantities of water. Pump stations are often be sited at small purification works or as booster pump stations along pipelines.

Normally the electrical power supply will be provided by Eskom or the local authority.

10.2 Pump selection

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, is calculated and plotted as a graph above the required static head. Pump Station losses, including those of all valves in the pumpline, should be included in the calculation of the system curve.
- The pump performance curves are then 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 will intercept the system curve at the station duty point.
- An ideal pump selection will result in each Pump Duty Point falling at or very near to the pump Best Efficiency Point (BEP).
- When only one pump in a multi-pump arrangement is operating, the intercept with the system curve will 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 what the pump will demand is ensured under the worst possible operating condition.

10.3 Pump standby capacity

For Surface Water Pump Stations:

- 100% standby capacity for single pumps
- 33% minimum standby acceptable for larger pump sets.

For Borehole Pump Stations:

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

10.4 Power requirements for pumps

The power supplied to a pump must equal the total power required for the duty as calculated above with an allowance for pump and motor efficiency, and in addition the following factors must be added:
For Motors > 25 kW: Add 10% to power requirement
For Motors < 25 kW: Add 25% to power requirement

10.5 Pump control

Centrifugal pumps should be started and stopped against a closed valve.

All controls should be designed to operate "fail safe".

All pumps should be provided with emergency stops adjacent to the pump.

Pumps may be controlled manually, by means of downstream pressure (reservoir pressure) or by means of telemetry. The following rules apply:

MANUAL Pump Control:

- Top Open Inlet to Storage or Combined Bottom Inlet/Outlet.
- Manual or Timer Control for starting and stopping of pumps.
- Manual override switch for starting and stopping of pumps.

PRESSURE Pump Control:

- Top or Bottom inlet to storage.
- Float Level Control.
- High Pressure Cut-Out switch for pumps – must always switch off pumps, even when on manual.
- Time delay restart for pumps (minimum 30 mins.)
- Manual override switch for starting and stopping of pumps.

TELEMETRY Pump Control:

- Top Open Inlet to Storage or Combined Bottom Inlet/Outlet
- Automatic Telemetry Cut-In and Cut-Out Level Control for pumps.
- Settings for Cut-In levels:
  Reservoirs: 4 hr x GAADD below TWL
  Elev. Tanks: 1 hr x GAADD below TWL
- Minimum distance of 150 mm, in all cases, between cut-in and cut-out levels.
- Manual override switch for starting and stopping of pumps.

10.6 Pump station building

The suggested requirements for a pump station building are as follows:

- Pump station floor level: determined in conjunction with the minimum N.P.S.H. (net positive suction height) of the pumps. The effect of surge in the suction pipeline and manifold should also be checked for pump start-up and trip conditions.
- Top of the pump well should not be below the 1:50 year flood level for pump stations built along a river. This can be raised to say 1:100 year flood level if the pump station is downstream of a dam wall. If the pump station is built upstream of a dam wall then the motor floor must at least be 2,0 m above the 1:100 year or the high flood level, whichever is the greater.
- The pump station should be accessible during all weather conditions.
- The protective fencing must be designed in accordance with the protection requirements of the area, usually barbed wire spaced at 100mm intervals with razor-cut flat coils fencing materials.
- Stormwater to be drained away from the pump station during the construction and operation phase.
- Corrosivity of the soils surrounding the pump station concrete structure should be investigated.
- Pump wells should be anchored to prevent flotation.
- Light fittings must be vandal proof. Light bulbs must be easily changed. Fluorescent lighting is acceptable. Security lighting to be provided with daylight switches. High masts to be furnished with lightning down conductors.
- Generally no external windows will be allowed. Fixed and sturdy ventilated louvers with insect screens must be provided instead.
- Facilities (crawl beam and loading bay) for the safe removal of the pumps and motors should be provided where the weight of the equipment is such that it cannot be manhandled.
- The loading bay entrance doors should preferably be of the roller shutter type (rugged design).
- Normally steel roofs should be used. Reinforced concrete roofs could be three times as expensive as steel roofs. Timber should not be used.
- The following stair dimensions are suggested:

Risers: 160 to 178 mm high
Treads:265 to 300 mm long

- Off shutter concrete finished areas i.e. pump well walls, concrete columns, etc., should generally not be painted.
- Hot dip galvanised treatment
  All internal handrails, steel cat ladders, steel stairways and eggrate flooring.
  Steel windows, doors and door farms.
  Roller shutter doors.
- Structural steelwork to be protected and painted as per SANS 1200 HC.
- Generally vinyl tiles on floors except loading bay, workshops, store rooms and very low traffic areas around and in pump well which should be concrete wood screed.

NOTE: Many of the pump station guidelines are also applicable to the design of water treatment work structures and reservoirs.

10.7 Pumpline components

10.7.1 Baseplates

Pumpset baseplates should be machined and must be adequately anchored and grouted to robust concrete plinths. Pumpset and pipework out-of-balance thrust loads must be adequately restrained by concrete or steel supports and pipework must be supported to the floor or walls within the pump station.

Pumps and motors should be located by dowels, once aligned.

10.7.2 Pumps

Suitable pumps are:

- single stage end-suction or horizontal split,
- multi stage, horizontal, for treated water (not recommended for raw water owing to excessive wear on balancing disc),
- single or multi stage vertical in raw water wet-well application (product-lubricated with thrust bearing outside the flow tube), or
- progressive cavity pumps.

10.7.3 Pump coupling

Belt drives are unacceptable for electrically driven pumps.

10.7.4 Pump components

Impellers or rotors should be either a zinc-free bronze or stainless steel.
Cast iron impellers are not acceptable.
Impellers and pump casings should be fitted with renewable bronze or stainless steel wearing neck-rings.

Pump testing should be to BS 5316 part 2 class B undertaken at an acceptable test facility, e.g. SABS or at the pump manufacturer if test facilities meet with the standards.

10.7.5 Motors

Limited to motors of 185kW (400V).

Motors should be (TEFC.) Totally Enclosed Fan Cooled(1C 0141) with cast iron body and should be 3 phase 400V induction type.

10.7.6 Pumpset speed

Pumpset speed should not be greater than 1 480 rpm (4 - pole).
2-pole motors ± 2 800 rpm are only acceptable under exceptional circumstances.

10.7.7 Switchgear enclosures:

All switchgear and control panel enclosures should be rated IP54.

10.7.8 Valves

See **DWS Standard 2510 in *Specifications Folder*.**

Isolating valves:

Double flange gate valves should be specified (resilient seal valves up to 1,6Mpa).

Isolating valves at both pump suction and pump delivery should be hand operated and double-flanged to permit stripping of the pump or control valve. A wafer type valve will not permit this and is therefore unacceptable.

The upstream (suction) isolating valve should have the same pressure rating as the delivery isolating valve.

Control valves

Flow and pressure control valves are not acceptable. In order to reduce excessive surges, double flanged reflux valves are preferred. Alternatively surge tanks should be provided or an alternative form of surge control.

Mounting of butterfly valves
(or valves with adjustable seals with specific reference to their use in or relating to pump stations)

The seal should always be accessible from the side of the valve "facing the pump".

The direction in which the valve is to be placed, should be specified by the supplier.

Butterfly valves should be supported and not fixed.

10.7.9 Instrumentation and protection

All instrumentation must be mounted on vibration free surfaces.

Temperature sensors (pump thermal protection) should be fitted in the pump casing to protect the pump against closed valve conditions.

RTDs (Resistance Temperature Detectors) are preferred for motors greater than 50kW and should be embedded in the motor windings, two per phase providing one set spare.

In typical community water supply size of pump station, motor or pump bearings as well as pump glands need not be monitored.

Pressure sensors

A low suction pressure sensor should be provided and located between the suction isolating valve and the pump suction flange. This device should monitor and ensure that the pump does not operate under conditions that will result in cavitation within the pump.

A pump delivery pressure sensor should be located between the pump delivery flange and the reflux or other control valve. This device should monitor two conditions:

(1) on start-up, that the pump is generating full pressure and it is safe to open the delivery isolating valve, and
(2) in operation, that when the level controlled valve at the receiving reservoir located at the upper end of the rising main is closed, the ensuing increase in pump delivery pressure should be employed to stop the pump. The delivery isolating valve should then be re-closed before restarting the pump.

Pressure gauges

Each pumpline should be equipped with two pressure gauges. One should display the pressure at the pump suction flange, the other, the pressure at the pump delivery flange.

In addition, one pressure gauge should be installed to measure the pressure in the station delivery manifold itself.

Pressure gauges should be glycerine filled and be calibrated in metres head of water. The range of operation should be from zero to 50% in excess of the pump "closed valve" pressure.

All pressure gauges should be supplied with isolating and drain cocks, piping, and fitted with a pulsation damper.

Flow meters

Usually ultrasonic flowmeters should be used where electronic type metering is required. Where this type of meter is not justified mechanical type meter are acceptable.

10.7.10 Control panel

All panels should have a test button to test all lamps. For indication lamps use only cluster type LED with coloured lens caps (blue LED's are not available).

The pumpline control panel (whether combined with the motor starting switchgear, or separate) should contain the following displays:

- Green lamp - "pump running".
- Red lamp "pump stopped".
- White lamp "pump tripped".
- Blue lamp "pump available".

The blue "pump available" lamp should be illuminated only when all safety conditions being monitored are healthy, i.e.:

- motor winding temperature sensors, and
- suction pressure sensor healthy.

In addition electric power should be available.

Should any one of these safety sensors indicate an "unhealthy" or faulty condition the pump should be tripped and the white "pump tripped" lamp should be illuminated. In addition, the station panel alarm should sound.

Audible alarm devices should be time controlled (3 minutes) as these devices are sometimes sabotaged by nearby residents.

Also mounted on the control panel should be the following push buttons:

- pump start - green
- pump stop - red
- emergency stop - red mushroom (lockable)
- alarm accept (to silence station alarm) - black.
- trip cancel (to cancel white lamp after fault is rectified) - black.
- Auto/manual switch if remote auto controls are used, such as level devices or telemetry. When in manual mode warning devices must still be operative.

11 LOW VOLTAGE ELECTRICAL EQUIPMENT

11.1 General guidelines

The DWAF General Technical Specifications (Electrical) (GTSE) are included in the ***Specifications Folder***.

SANS 0142 and other standard specifications as set out in the GTSE as well as regulations of Eskom and local authorities must be followed where applicable.

The Occupational Health and Safety Act (Act 85 of 1993) applies in all instances.

11.2 Design report

The design report must include the results of a quality investigation of the electrical supply. This could determine the starting methods to be used by the various electric motors. Direct on line starting is always preferred if possible.

11.3 Important aspects to consider

Cognisance should be taken of the following aspects:

- Environmental;
- Aesthetics;
- Safety to equipment and personnel;
- Spares cost & availability;
- Ease of operation;
- Future extensions;
- Maintainability;
- Availability;
- Serviceability;
- Technology improvements;
- Quality of equipment;
- Energy conservation;
- Quality of electrical supply; and
- Economics.

11.4 Maximum voltage

No voltage higher than 400V should be used. Higher voltages must remain the responsibility of the electricity supply authority.

11.5 Metering points

A dedicated transformer should be negotiated with the relevant supply authority for each metering point to avoid quality of supply problems originating from the supply authorities 400 volt system.

The total cost of the supply point is important and should be determined before final designs are submitted.

11.6 Motors

Motors must meet the necessary pump requirements.

11.7 Power cables

Power cables must be suitable for short circuit and environmental conditions.

11.8 LV switchboards and motor control

11.8.1 Construction

The following requirements are recommended for switchboards:

- IP54 enclosure;
- Free standing;
- Extensible;
- Flush tiers front and rear;
- Accessible front and rear with hinged doors in front and removable panels at the rear;
- Door locking and safety lockout systems are required;
- Steel construction (2mm);
- Colour white internal and lighter electric orange external;
- Provide ventilation slots on face panels and doors with vermin screens behind slots;

- Ensure that all panels are totally vermin proof; and
- Use substantial gland plates at bottom of panels (3mm thickness).

11.9 Switchgear

11.9.1 Circuit breakers

The following requirements for circuit breakers are recommended:

- The incoming circuit breaker of the main LT switch board, which receives the supply from the supply authority or transformer, must be equipped with adjustable earth leakage protection as well as an adjustable time delay facility to create the necessary discriminating between this breaker and other earth leakage protectors further down the line.
- Selective tripping between incoming and outgoing circuits must be provided.
- Protection grading must be effective for all operating conditions.
- Where circuit breakers are used to protect contactors, motor protection circuit breakers equipped with shunt trips to trip the circuit breaker in the event of short circuit or earth faults should be used. The contactor should not be required to clear these types of faults.
- Fast acting circuit breakers should be used in all instances.
- Motor circuit breakers should allow for long duration (up to 10 second) start ups.
- HRC fuses should not be used as these tend to get tampered with and are not always readily available.
- All circuit breakers must be selected to handle the maximum possible fault current taking into consideration possible future extensions involving and increase in the available fault current.

11.9.2 Isolators

Isolators should be load breaking \ fault making type.
Isolator should be lockable in the OPEN position.

11.9.3 Contactors

Contactor should comply with IEC 158-1 for Class AC3 unless the specific duty requires a higher rating.
De-rate contactors should be used in areas where ambient temperatures exceed 35^0C.

11.9.4 Switch gear general

No bypass facilities on protection equipment, level relays, etc. are allowed.
All power, signal and control cables must be numbered on site and on drawings.

11.10 Motor protection

The following requirements for motor protection are recommended:

- Comprehensive motor protection is required where the requirements are such that the normal thermal overload protection will not be adequate. A versatile, multifunction motor protection unit or relay is therefore to be used.
- For motors below 15kW thermal overload protection may be used provided single phase, phase reversal, and under load protection is provided. For under load protection, phase angle type relays may be used.
- Trip mechanisms should be settable with front panel mounted buttons and trip conditions should have indicator lamps on the front panel.
- Under and over voltage protection must be provided to disable the motor starter control circuits excluding the remainder of the pump station.
- Automatic re-start must be prevented when trips occurred due to over/under current conditions. In such instances make use of an alarm plus a manual restart.
- Provide adequate motor, pump, and pipe earthing.

11.11 Indication and instrumentation

The following instrumentation is required:

- Combined thermal demand and instantaneous ammeters on all incomers, and transformer feeders.
- One ammeter per phase.
- Motor starter panels one ammeter.
- Voltmeter with selector switch on each incoming panel.
- Maximum demand/kWh combination meters will normally be required on the incoming sections.
- Power factor indicating instrument where warranted.

Other indication will include:

- Run lamp;
- Emergency Stop lamp;
- Ready lamp (not applicable in the case of boreholes and small pumpstations);
- Overload lamp;
- Motor winding lamp (over-temperature) where motor winding temperature sensors are available in motors;

- Supply Voltage lamp; and
- Running hour meter.

Other requirements for indication are:

- Where necessary for safety reasons a control voltage should be 24v.
- All alarm indication must be latched and reset by a reset button.
- Only mercury bulbs or 3 wire level relays should be used for level controls in reservoirs. Ultra sonic level sensing is not acceptable.
- Borehole level sensing should be done with equipment using normal wires.
- To assist operators, three "cable live" neon indication lamps should be provided on incoming supplies.

11.12 Control

11.12.1 General

Easily maintainable systems using relays, etc. must be used.
PLC’s are only to be used where warranted.

If PLC's are used (see above) full lighting protection must be provided for all inputs, outputs, and power supplies.

11.12.2 Local control

Local control should consist of pushbuttons as follows:

- Start;
- Stop;
- Emergency Stop (At motor starting cubicle and at motor);
- Reset; and
- Lamp test.

11.13 Power factor correction

Power factor correction must only be provided where it can be proved before-hand that it is economically justified.
Power factor correction equipment, if provided, should preferably be mounted directly on the motor.
Automatic power factor equipment should be avoided.

11.14 Earthing

The following requirements for earthing are recommended:

- Earthing may consist of an earth mat, trench earth, electrode earth, or a trench and electrode combination scheme.
- An earthing survey must be carried out by a specialist where necessary.
- All earthing must be connected to a common earth bar at the lowest possible point where separate systems are provided for instrumentation, LV and MV.
- All exposed earthing must be PVC insulated copper conductors. All other must be bare copper conductors.
- Maximum resistance to earth is 1Ω for LV systems and 2Ω for MV systems.
- The supply authority's requirements regarding earthing must be taken into consideration.
- One drawing showing the overall arrangements must be provided.

11.15 Lightning protection

The requirements for lightning protection are:

- Lightning protection must be provided for safety purposes as well as for the protection of equipment and instrumentation.
- Surge arrestors must be of the metal oxide type in accordance with SANS 172.
- Guard against the use of long control cables between eg. reservoirs and pump stations to minimise damage due to lightning.
- Use MOV (5 - 10kA) surge arrestors on both ends of control cables between eg. level sensing equipment and motor controls.
- Provide lightning protection for instrument supply cables.
- Provide lightning protection for panel incomers.

11.16 Conduit wire ways and conduit

11.16.1 Conduit

All conduits must be galvanised steel conduit in accordance with SANS 1665 and should be surface mounted.

11.16.2 Wire ways (conduit and trunking)

Separate wire ways must be used for normal power and lighting, emergency power and lighting, standby power and lighting, control wiring, and extra low voltage wiring.

11.16.3 Cable ways

The requirements for cable ways are:

- Cable routes should be specified. This should be in trenches, in floors, or cable ladders against walls.
- Floor trenches should be filled with sand and screeded over after completion of the installation. Provision should be made for draining of cable trenches. Gland drip water should be piped into a no-fines opening into the trench, next to the pump set in this case, to keep the sand wet.
- Heavy duty galvanised beehive type racks supported at least every 750mm on galvanised angle iron brackets should be used to support aerial and vertical cables.
- Stainless steel straps should be used to attach cables to cable racks, masts, etc.
- Pipes must not be used for cable ways for motor cables. Channel iron or other protection and support that allows sufficient ventilation should be used.

11.16.4 Switches and socket outlets

Light switches should be placed in galvanised steel box in accordance with SANS 1065, 1,2m above finished floor level.

16A Switched socket outlets should be placed in 100mm x 100mm boxes.

Three phase welding sockets with built in earth leakage should be provided.

11.16.5 Wiring

One circuit per conduit wire way is allowed. All un-armoured conductors should be installed in conduit or wire ways. All cables and conductors must be protected by suitably rated switch or fuse gear.

Conductors originating from different switchboards may not be installed in the same wire way.

Minimum conductor sizes are:

- Lighting circuits 1,5mm^2 power and 2,5mm^2 earth conductors
- Socket outlets 2,5mm^2 power and 2,5mm^2 earth conductors
- Stove circuits 10mm^2 power and 6mm^2 earth conductors
- Bell circuits 1,5mm^2
- Clock circuits 1,5mm^2

11.17 Lighting, luminaires and masts

11.17.1 Lighting

Task lighting of 160 lux is required for each pump.

Walkways, footpaths, staircases, general movement areas etc. must be lighted according to SANS 10098.

Maintained emergency lighting must be provided where applicable.

11.17.2 Luminaires

For ease of maintenance, light fittings should be mounted against walls at a maximum height of 3,5m.

Depending on the application and the required lighting levels fluorescent, incandescent or HPS luminaires may be used.
Exterior luminaires are to be rated to IP65.
Luminaires manufactured from sheet steel or aluminium may not be used.

Highmast luminaires must be 250W HPS.

ES Screw in lamps incandescent fittings should be used.

11.17.3 High masts

Streetlights should be mounted on 8m standard poles with a 2m outreach.

High masts should be of the 12m hinged type with removable hand winch.

11.18 Standby generators

Where standby generators are provided, the change-over switches between standby and normal electricity must be both mechanically and electrically interlocked and conform to the supply authorities requirements.

Batteries for standby generators should be charged from the mains supply.
Fuel tank level and battery voltage sensors should be provided (for possible use with telemetry systems).

12 TELEMETRY

12.1 Maintenance

It is normally recommended that telemetry be maintained by maintenance contractors.

12.2 General guidelines

Telemetry will normally be required where there is a need to exchange data and information between two or more distant or remote installations or sites, e.g. between a remote reservoir and a pump station or control room.

The design engineer should take consideration of the following:

- Environmental impact;
- Safety to equipment and personnel;
- Affordability;
- Ease of operation;
- Maintainability;
- Serviceability;
- Compatibility with existing systems;
- Quality;
- Aesthetics;
- Best practice;
- Spares costs and availability;
- Future extensions;
- Availability; and
- Technology improvements.

12.3 Typical system configuration

A typical system may consist of a master station and a number of outstations. Depending on the distance and terrain, repeater stations may be required. Typical data or information that may be transmitted is for example:

- valve position;
- reservoir level;
- pump status, e.g. running, stopped, tripped etc;
- start/stop commands; and

- camera images.

The telemetry installation consists of the following elements:

- transducers and field instrumentation;
- cabling;
- communication system; and
- control systems.

To protect and enable the above to operate two ancillary systems are required, namely:

- power supplies; and
- lightning protection and earthing.

12.4 Transducers and field instrumentation

12.4.1 General

In most cases the instrumentation, transducers and sensors will be supplied and installed by the various other Contractors, e.g. electrical or pump contractor. However situations may arise where no other Contractors are employed and in these cases the supply and installation of the instrumentation equipment must form part of the telemetry installation.

12.4.2 Technical requirements

In general all transducers/sensors must comply with the following -

- analogue outputs 4 - 20 mA
- supply voltage 24 V DC (nominal)
- accuracy ± 0,3 %
- reliability + 5 000 hours
- housing suitable for environment.

12.4.3 Back up requirements

Where valves are controlled, limit and back up switches must be provided.
Level transducers must be backed up by float switches.

12.4.4 Compatibility

Cognisance must be taken of compatibility with existing equipment.

12.5 Cabling

12.5.1 Power cables

The installation of these cables are covered in the Department's Specifications on Electrical Installations included in the ***Specifications Folder***.

12.5.2 Data cables

For correct performance of cables for data transmission, the correct type and size cable must be selected for the application e.g. data transmission speed, noise, distance, type of data (analogue or discrete) etc.

As a general rule, the following should apply:

- Low data transfer rates: Low frequency type cables e.g. twisted pair;
- High data transfer rates: High frequency type cables e.g. co-axial cables, optic fibre or special type of twisted pair;
- High noise and lightning environment: Shielded cable or optic fibre cable.

The number of cables or pairs must make allowance for future extensions. Cables must be suitably protected against damage.

12.6 Communication system

The communication system consists of the following sub-systems:

- Radio equipment – Transmitters and receivers;
- Antennas and Masts;
- RF cabling;
- Power supply system; and
- Lightning protection and earthing.

12.6.1 Transmitter and receivers

The Transmitters and Receivers should comply with the requirements of SANS 300086.

The specification should address the following :

- RF output power Normally 2 - 30 W
- Modulation Phase or frequency
- Frequency stability 3 - 5 ppm

- Allowable audio distention less than 5%
- Maximum spurious radiation and harmonics < 70 dB
- Channel spacing 12,5 kHz.
- Number of channels 4 minimum
- Frequency bands VHF (68 - 88 MHz),
- VHF (146 - 174 MHz) and UHF (450 - 470 mHz)
- Microwave (2,4GHZ; 10GHZ)
- GSM (HSCO; GPRS; SMS)
- Input impedance 50 ohm.

12.6.2 Masts and antennas

a) Masts

Construction of masts should be metallic self supporting lattice or sectional pole.
Steel is preferred above 4m.
12m and above must have stay wires.
The finish should be galvanised steel.
The design load, including antenna, is a wind load of 160 km/h (and snow load where applicable).

b) Antennas

Gain:	6 dB depending on signal
Type:	Omni-directional or directional where applicable
Nominal impedance:	50 ohm
Material:	Aluminium.

c) RF cabling

All RF cabling must be low loss coaxial cable suitable for outdoor use.
Suitable protection must be provided to the cable where exposed to damage.
Minimum bending radius must be specified.

12.7 Control systems

12.7.1 Control modes

Local and remote control modes are required, i.e.. it must be possible to switch between local and remote control.
Both control modes can be either automatic or manual.
Distributed control should be employed with override and monitoring by the telemetry system.

Failure of the telemetry system should not affect the local control.
Telemetry must not be able to start or stop in local control.

12.7.2 Man machine interface

Computers must be specified as follows:

- 17 inch monitor;
- Pentium IV 2GHZ or higher
- 40G Hard Drive
- At least 512 MB memory.

A display unit must be provided or the existing display upgraded or reprogrammed at the master control panel to display all the data and control parameters from the out stations, including all alarms, equipment status, valve positions, levels, etc.
All controls should be effected from this interface, either automatically or by the operator when selected.
Sufficient data storage capability must be provided for backup and data storage.

12.8 Power supplies

Suitable power supplies with adequate battery back up facilities must be provided.

The batteries may be charged from one of the following sources:

- AC main supply with rectifier and protective equipment
- Solar cells
- WIVA chargers.

Solar cells will be used where no mains power is available.

Alarm signals should include the following:

- Low battery voltage;
- Mains failure (if applicable);
- Solar panel (if applicable);
- Intruder alarm;
- Communication failure.

In general the power supplies must conform to the following:

- Output voltage: 12 Volt for normal use or 24 Volt for transducers;
- Protection: Overcharging, under voltage, cut out, power surges, reverse polarity.

Rating:

- Data transmission only: 30%Transmit/Receiver 70% standby for 48 hours;
- Data and Voice transmission: 50% Transmit/Receiver 50% standby for 48 hours.

12.9 Lightning protection and earthing

Suitable protection must be provided to protect equipment, including:

a) Earth Electrode System

- Maximum resistance 5 ohms. 1 ohm if possible;
- Test points are to be provided;
- SANS 10199 is applicable;
- Concealed joints and interconnections brazed or welded.

b) Bonding all exposed steelwork and other steelwork that may become "live" due to equipment faults, static build up or lightning strikes are to be bonded.

c) Lightning Protection

All equipment should be considered exposed to lightning strikes and suitable protection must be provided.

All instrument boxes should be earthed by a 70 mm copper earth wire.

12.10 Documentation and training

Complete maintenance and operating manuals must form part of the scope of supply.

As-built documentation must be provided and must include:

- Control logic;
- Cabling; and
- Physical layout.

Operating and Maintenance manual must also be provided.

12.11 Spares

A full set of spares must be included with the manuals.

13 PIPELINES

13.1 General

Water supply is delivered under pressure either by gravity or by pumping.

Water supply pipelines are generally designed to convey water free of suspended matter and generally of potable quality.

Laying and jointing are important operations that contribute to the life of a pipeline and to the level of service provided. These can constitute a significant factor in pipe selection, especially where labour based construction methods are utilized.

The prime function of any pipe and pipe material is that, for the expected life of the pipeline, there is adequate resistance and strength to withstand all forces that can be expected to be imposed on the pipe. These forces and requirements include:

- Internal forces including internal pressure and pressure surges;
- External forces including earth pressure and superimposed loads;
- Water tightness; and
- Corrosion.

Generally refer to **DWS 1110 Clause 4** (included in the ***Specifications Folder)*** for the design and setting out of pipelines.

13.2 Design capacity

See Planning and Design Parameters in the Preliminary Design Section.

13.3 Pipeline materials

The pipeline material that provides the lowest life cycle cost should be selected. The selection procedure as proposed in **Section 3 of Darling and Hodgson's "Pipe Selection Manual, 1996"** is recommended.

Suitable pipeline materials are tabulated below:

Pipe Materials, Classes and Acceptable Sizes:	**DWAF DWS Specification**	**Class (bar)**	**Sizes (mm)**
Minimum pipe size for reticulation: 50mm nominal diameter			
HDPE (SANS 533)	None	Min. Class 6	15 - 75
uPVC (SANS 966 or ISO 4422)	DWS 1160	Min. Class 6	50 - 250
Note: 125 and 140 mm sizes are not recommended for uPVC pipes, due to the lack of standard fittings.			
21GRP	DWS 1150	Min. Class 6, Max. 25 bar	Min. 150
Galvanised Mild Steel (SANS 62)	None	Medium Duty	15 – 150
Steel (> 150mm)	DWS 1130	Min. API 5L Grade A Min. wall thick. t = 4,5 mm Slenderness, D/t < 120	Min. 200
	Max. Press. incl. surge (m) = 120*t/D, where S = Yield Point Stress (MPa) and D = Outside Dia (mm). Formula assumes max. of 60% of yield stress mobilised.		
Protection to steel pipes (> 150 mm):	Generally bitumen fibre wrap coating with cement mortar lining or epoxy lining and cathodic protection – see DWS 1131.		

13.4 Pipeline velocities

The following maximum and minimum pipeline velocities are recommended:

- 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,

13.5 Pipe friction factors

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

Pipe friction factors are provided in the table below:

Pipe Friction Factors (Absolute Roughness, k_s, mm)

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

13.6 Depth of pipe cover

The minimum depth of cover to main pipelines are:

- Generally: 600mm
- Under cultivated land: 900mm
- Road/Railway crossings: 1000mm

Additional protection should be provided to pipes under roads or railways where required.

13.7 Vacuum pressures

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

13.8 Cover

750mm minimum cover with 1000mm cover required under road crossings.

13.9 Trench width

Allow for at least the pipe diameter plus 150mm on both sides for small diameter pipelines to ensure that backfilling is effectively rammed. The minimum trench width should be 500mm.

13.10 Bedding and backfill (including material)

According to SANS 1200 and DWS 1110 (see ***Specification Folder***) where applicable.

13.11 Slope

A slope of steeper than 0,3% is required to avoid air pockets.

13.12 Meters

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

The supply to each local authority should be separately metered.

All stand pipes should be measured.

Where house or yard connections are provided, the consumption of each individual household should be measured.

13.13 Delivery point

For a basic level of service in rural communities the delivery point should be the stand pipe or a yard tank.

13.14 Pipe markers

Refer to DWS 1110 in ***Specifications Folder.***

Pipe markers are required at a minimum spacing of 500m unless the pipeline follows a road.

All bends should be marked.

13.15 Air release and air intake valves

Air valves should be provided on summits of main 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.

Refer to **Messrs Mulric Hydro Projects' catalogue No. RBX 0001** for the selection and positioning of air valves.

Diameter of branch below air valve should be as follows:

- Pipeline =< 200 mm NB: Install an equal T piece below 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 > 600mm NB.

13.16 Scour valves

Should be provided at all low points.

Scour valves should be so sized that the pipe can be drained between the isolating valves within 2 hours.

The diameter of the drainpipe should be 0,4 times the diameter of the main pipe but should be an equal T for pipelines =< 200mm NB.

13.17 Isolating valves

Should be placed:

- At all pipeline intersections in the branch and main line.
- At an approximate distance of 1,5km, 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.

13.18 Valve chambers

Valve chambers of robust construction should be provided for all valves.

Valve chambers must 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 secure against vandalism.

13.19 Pressure control valves

Pressure control valves are not favoured and their use should be minimised.

Break pressure tanks should be used for pressure reduction where possible, but the correct placing of reservoirs is preferred.

13.20 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.

13.21 Structural design

Pipelines should be designed for internal and external pressure including surge pressure.

The structural load bearing capacity of the pipe is specified by the manufacturer and care should be taken not to expose the pipe to loading conditions other than that intended by the manufacturer.

13.22 Corrosion protection

Refer to DWS 1131 in ***Specifications Folder***.

13.23 Couplings

Two major categories are generally used, namely rigid and flexible joints.

Flexible joints are defined as those joints that allow some telescopic movement or angular flexure of the adjoining pipes.

13.23.1 Rigid couplings/joints

13.23.1.1 Flanges

Flanges should be attached to pipes by metal-arc welding, the weld preparation being in accordance with the requirements of **BS806 Type 6** unless otherwise specified.

A slip-on welded flange is suitable for all design pressure conditions covered by BS flange tables up to and including **Table J** and design temperatures not exceeding 425ºC, with pipes 80 mm and over.

Flanges should be in accordance with **BS 4504**.

13.23.1.2 Welded butt joints

Butt joints welded by the metal-arc process should be in accordance with the requirements of **DWS 1130 and DWS 1110**.

13.23.1.3 Screwed couplings

Pipes should be screwed taper and sockets parallel thread according to SANS 1109 or ISO 7/1.

Galvanized pipes may be threaded after galvanizing.

The use of parallel threads on light pipes are not recommended.

13.23.2 Flexible couplings

All flexible coupling should be able to withstand an internal pressure equal to or greater than the design working pressure of the pipe.

The couplings should be able to withstand any external pressure due to installation conditions without the presence of an internal pressure.

Spigot and socket joints utilizing a rubber ring as a seal should be watertight under working pressure with a shear force equal to the expected external load applied to the coupling.

Rubber O-rings used for sealing should not elongate more than 25% of the original length when stretched over the spigot end of a pipe. See BS 2494.

Rubber o-rings should not be exposed to ultra-violet radiation or ozone for periods longer than the time required for installation.

Where a pipeline is likely to be subjected to any abnormally corrosive condition, the pipe manufacturer should be contacted in advance so that they may advise on the suitability of their joints for the purpose, or alternatively in collaboration with their rubber supplier, provide rings that will meet the requirements of the situation.

Sleeve type joints using a flexible plastic sleeve must conform to the misalignment test according to the relevant SANS standard for that specific type of pipe utilizing the coupling.

The draw and slew movement of the coupling will be in accordance with the requirements of the relevant SANS standard for that specific type of pipe utilizing the coupling.

13.24 Fittings

13.24.1 Reducers / diffusers and inlets

The range of angle of deflection for concentric or eccentric diffusers (enlarging diameter) should be between 2,5 – 30 degrees.

Where available NPSH is a problem, rounded inlets should provide better flow characteristics and less friction losses.

13.24.2 Bends

Refer to **DWS 1130**.

Elbows should not have a bending radius smaller than the outside diameter of the pipe.

Medium and long radius bends should not have a radius larger than seven times the outside diameter of the pipe. Long radius bends normally have a radius of approximately three times the outside diameter of the pipe.

Standard angles of elbows are: 90, 45 and 22,5 degrees.

13.24.3 Dividers

All flow dividers will cause change in flow direction and should therefore be properly anchored.

Standard angles of deviation from the main pipe are: 90, 60, 45, 22.5 and 11 degrees.

13.24.4 Puddle or thrust flanges

Puddle or thrust flanges should be provided where a pipe passes through a water retaining structure or chamber.

A thrust flange will assist in the transfer of axial pipe forces due to water hammer or surges.
The flange should be designed structurally to withstand the shear forces it will experience.

Steel pipelines should be insulated with paint where they pass through concrete.

13.24.5 Reinforced specials

The procedures developed H.S. Swanson et al have been incorporated **into AWWA M11 - Steel pipe - A guide for design and installation**, and are generally used in the design of reinforced specials.

13.25 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
DWS1160	Design, manufacture, supply, and installation of Polyvinyl Chloride (PVC) Pressure Pipes and fittings
DWS 2510	Supply of valves

14 RESERVOIRS

14.1 Storage

Reservoirs should be designed for the following storage capacities:

- Elevated storage capacity should be designed for 2 hours of peak daily demand for the area served by the elevated storage.
- Ground level reservoirs that are gravity fed: 24 hours of annual average daily demand.
- Ground level reservoirs that are pump fed from one source without a standby power supply or pump: 48 hours of annual average daily demand (all storage inclusive).
- Storage based on 60 litres per capita per day demand.

14.2 Storage for small ground water schemes

If ground level storage can be located close to the village and provide the required residual head for the reticulation, then 36 hours or 48 hours storage at 60 lcd should be provided according to the number of boreholes utilised.

However, if achieving the minimum residual pressure requires an elevated tank, then it is recommended to omit the ground level storage.
The elevated tank should only be sized for 16 to 24 hours of 25 lcd (10 years design horizon), and the borehole pumps should pump directly into the tank.

An elevated tank so sized will be adequate in the short term and will be a suitable investment for use as an elevated tank in conjunction with ground level storage at a future date.

14.3 Design

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 tanks must have roofs.

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.

14.4 Materials

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

14.5 Metering

Bulk metering is essential.

Whether the meter should be placed at the inlet or the outlet depends on the institutional or contractual arrangements.

14.6 Level control and indication

The reservoir must not be capable of spilling under normal operating conditions.

A water level indicator should be provided.

14.7 Position

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

14.8 Break pressure tanks

Correctly placed reservoirs are preferred in place Break Pressure Tanks, but when this is not practical, the following guidelines are 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, but if required, then provision must be made for adequate maintenance.

15 STAND PIPES, YARD TANKS AND OTHER CONSUMER CONNECTIONS

15.1 Stand pipes

A concrete plinth should be provided which allows the water to drain into a soak-away (sump with crushed stone).

The tap should be high enough for a container to fit underneath. Preferably a stand should be provided for the container to stand on, with a higher tap.

The tap should preferably be of the push button or self-closing type.

Consumer off-takes directly on pumping mains are not acceptable.

15.2 Yard tanks

The yard tanks should be approximately 200 litres in size to provide adequate storage for daily supply. The flow into the yard tank must be regulated by means of a flow constraint mechanism to maintain supply at approximately 200 litres.

The level of the outlet must be high enough to ensure a 25-litre container can fit easily for filling.

As in standpipes, a concrete plinth should be provided below the outlet to allow waste to drain into a soak-away (Sump with crushed stones).

Sunlight entry into the tank should be prevented to prevent algae growth.

15.3 Valves

An isolating valve should be provided at each standpipe.

15.4 Pressure

The minimum pressure at the hydraulically highest tap under a dynamic loading of 80% of the stand pipes being open should not be less than 6m.

The maximum static pressure should be 90m.

15.5 Minimum flow

The flow rate from the outlet of a standpipe should not be less than 10 litres per minute. For yard tanks it should be a maximum of 6000 litres per household per month.

15.6 Coverage

A maximum of 25 households or 100 people per stand pipe.

15.7 Walking distance

A maximum of 200m where feasible.

16 VENTILATED IMPROVED TOILETS

16.1 Introduction

Providing adequate sanitation facilities for residents is a major challenge in all developing countries. Those who have inadequate sanitation may be using a bucket system, unimproved pit toilets or the veld or any toilet which is not properly operated and maintained.

When a sanitation system fails, or is inadequate, the impact on the health of the community and the negative impact on the environment can be extremely serious. Outbreaks of diarrhoea and of cholera could occur.

The VIP toilet has a number of advantages over other toilet systems. The capital and operation and maintenance costs of a VIP are low, standard designs are available, only semi-skilled labour is required for their construction and the availability of a constant supply of water is not a factor.

The purpose of this standard is primarily to assist authorities and funding agencies in settting acceptable minimum standards for the design and construction of VIP toilets.

Individual households often copy the VIP toilets constructed by nearby formal programmes. It is hoped that this standard will create an expanded sphere of influence in that the VIP toilets constructed in accordance with this standard should stand as examples for surrounding communities who wish to build their own.

16.2 DefinitionS

Ventilated Improved Pit Toilet (VIP toilet) is a toilet which comprises:

- a pit into which the excreta falls and from which the liquid fraction seeps into the surrounding soil;
- a slab which covers the pit and which has two holes, one for the excreta to fall through and one for the vent pipe;
- a superstructure which provides privacy and which prevents light from entering the pit;
- a vent pipe which removes odour from the pit;
- a fly screen at the top of the vent pipe which prevents flies from entering the pit and which also prevents flies that have entered the pit from leaving through the vent pipe.

The Strategic Framework provides various definitions relating to a basic sanitation facility, a basic sanitation service and the eradication of the bucket system, as follows:

Basic sanitation facility is:
The infrastructure necessary to provide a sanitation facility which is safe, reliable, private, protected from the weather and ventilated, keeps smells to the minimum, is easy to keep clean, minimises the risk of the spread of sanitation-related diseases by facilitating the appropriate control of disease carrying flies and pests, and enables safe and appropriate treatment and/or removal of human waste and wastewater in an environmentally sound manner.

Basic sanitation service is:
The provision of a basic sanitation facility which is easily accessible to a household, the sustainable operation of the facility, including the safe removal of human waste and wastewater from the premises where this is appropriate and necessary, and the communication of good sanitation, hygiene and related practices.

[A Ventilated Improved Pit toilet (VIP) complies with both the old and revised definitions of a basic sanitation facility.]

Eradication of bucket toilets:
The bucket system is an unsuitable and inappropriate level of service. All water services authorities must identify and implement programmes for the eradication of all bucket systems by 2006.

The social, economic and cultural circumstances in the community,the geographical location and the technical characteristices of the different sanitation facilities all play major roles in the choice of the most appropriate sanitation system. In most situations, however, the ventilated improved pit (VIP) toilet together with good domestic health and hygiene practices will meet the requirements of a basic minimum level of service.

16.3 Operating principles

No water is needed to operate a VIP toilet (i.e. there is no flushing).

The pit should retain sufficient moisture for biological decomposition to occur, as the faecal matter will not break down if the pit is too dry and as a result the pit will fill up rapidly.

The egress of water from the pit should be adequate to prevent the pit being filled up rapidly with faeces and urine.

Provision should be made to access the pit of a VIP toilet through the slab in order to empty it manually or per vacuum action when required. Alternatively it should be possible for the VIP toilet to be moved when the pit is full.

Odour is removed from the pit through the action of wind blowing across the vent pipe and to a lesser extent by the air heating up on the inside of the vent pipe.

Flies, which are attracted into the pit by the smell, are trapped by the fly screen at the top of the vent pipe as they try to escape to the light.

16.4 Material

16.4.1 Concrete

The concrete should be capable of coping with the exposure conditions expected. Where necessary this will dictate cement and aggregate selection.

Recommended volumetric mix proportions are given in table 1.

Table 1 — Volumetric mix proportions for concrete and mortar

1	2	3	4
Purpose for use	**Cement** Wheelbarrow[a)]	**Sand** Wheelbarrow[b)]	**Stone** Wheelbarrow
Mortar for plastering	1	6	-
Mortar for bricklaying	1	6	-
Concrete for foundations and floors	1	3	4
Cover slab	1	2	2
[a)] The volume of 2 packets of cement is equal to the volume of 1 wheelbarrow of cement [b)] The type of sand should comply with the purpose, i.e. plaster sand for plastering, building sand for bricklaying and river or crusher sand for concrete			

16.4.2 Cover slab

The cover slab should generally be made of concrete or cement-mortar

16.4.3 Pedestal

The pedestal can be commercially fabricated with ceramic, polyethylene, glass reinforced plastic (GRP) and PVC or can be fabricated on site with wood, concrete, mortar or bricks.

16.4.4 Superstructure

The walls and roof can be constructed from a variety of local or prefabricated materials that are durable and weatherproof.

All hinges. Locks and handles should be of robust construction and resistant to corrosion.

16.4.5 Vent pipe

The vent pipe should be manufactured from uPVC pipe, brick, fibre cement pipe or cast iron.

16.4.6 Fly screen

The flyscreen should be resistant to damage from UV light, rain water and the gases emanating from the pit.

16.5 Design and construction of a VIP toilet

16.5.1 Pit

The recommended pit storage volume for a typical household (excluding the freeboard) is as given in Table 2.

NOTE A method for determining the pit storage volume as a function of the number of people using the pit, the solid accumulation rate and the desired life span of the pit is described in the publication *Building VIPs: Guidelines for the design and construction of domestic ventilated improved pit toilets*.

Freeboard height above the storage volume should be as given in Table 2 and Figure 1.

A pit can be round or rectangular. A round pit is more stable and is recommended in less cohesive soils.

For maximum efficiency, a pit should be large and deep. Round pits with diameter 1 m to 1,5 m and square pits with a width of 1 m to 1,5 m are the norm. Longer and shallower pits are acceptable in the case of rocky areas or areas with a high water table.

If the pit depth cannot be achieved due to rock or groundwater, an alternative such as a urine diversion toilet should be considered.

The size of the pit and the porosity of the soil surrounding it should be such that water will percolate faster out of the pit than liquids entering the pit.

A pit should not penetrate the water table

Only faecal matter, urine and cleansing water should be allowed to enter the pit.

Separate provision should be made for the disposal of grey-water and other household waste.

A drawing of a typical VIP toilet is shown in figure 1.

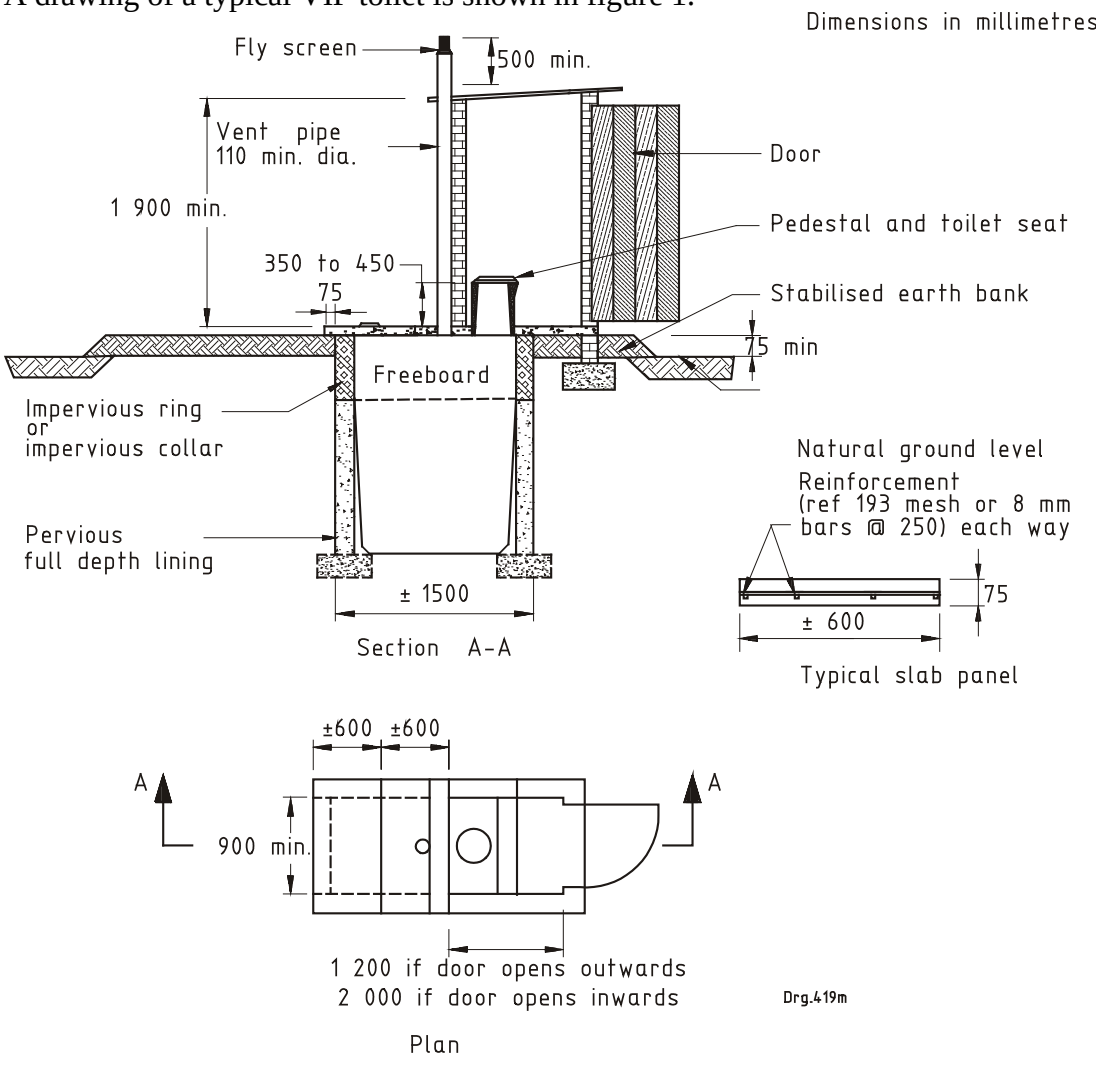


Figure 1 — Drawing of a typical VIP toilet

16.5.2 Location

The toilet should be situated downhill and at least 30 m from a borehole or a well (see SANS 10252-2).

The toilet should be near the house but so sited as not to endanger the structure of any building or any services on the site or on the border of the site.

The toilet should afford privacy of use by facing towards the house

If practical, more than one potential suitable location should be identified per stand where there is no pit emptying service.

Where the pit will be emptied by a vacuum tanker the toilet should be situated such that a vacuum tanker can approach to within 30 m of the toilet and not more than 2 m above the pit.

The toilet should not be built under or near trees.

16.5.3 Lining

Pits in stable soil which will be emptied by hand or pits moved when full need not be lined.

Pits in unstable soils and those that will be emptied by vacuum tanker should be lined.

The lining and soil should be sufficiently porous to allow water to seep out.

The lining can be constructed from concrete blocks, bricks, cement-stabilised soil blocks, stones or mesh-reinforced soil-cement.

16.5.4 Collar

A collar should be installed in all pits to:

a) prevent surface water or soil fines running into the pit;
b) support the cover slab and the mass of the users; and
c) support the mass of the superstructure if it rests on the slab.

A collar should be impervious and extend to at least 500 mm below the top of the pit and at least 75 mm above ground level.

A collar should be surrounded by a cement-stabilised earth bank or a shaped earth drain.

The same material that would be used for a lining is suitable for a collar.

16.5.5 Cover slab

The cover slab should generally be made of concrete.

The minimum thickness of the slab panel should be as given in Table 2. The mass of the slab should not exceed 150kg (to allow it to be moved by hand).

The reinforcing should be as given in Table 2.

Reinforcing have to be designed for a flat slab exceeding 1,5 m in span.

A cover slab should have two holes to accommodate the pedestal and the vent pipe. The shapes and sizes of the holes should correspond with the shapes and sizes of the pedestal and the vent pipe.

It can be circular or rectangular.

A cover slab should be properly supported by the pit lining or pit collar by allowing an overlap of at least 75 mm on each side.

Separate panels should be sealed against each other with a weak mortar mixture or window putty to obtain a fly-proof joint.

16.5.6 Pedestal and toilet seat

Some groups may require a squatting plate and not a pedestal.

The pedestal should have a smooth inside surface and be impervious to the penetration of water.

Pedestals can be commercially fabricated with ceramic, polyethylene, glass reinforced plastics (GRP) and uPVC or can be fabricated on site withconcrete, mortar or bricks.

Concrete or mortar pedestals should be painted with a waterproof paint.

The inside walls should be vertical or splayed slightly outwards from top to bottom (to minimize fouling).

The inside walls should be located directly over the pit. A side chute is not recommended.

The pedestal height should be between 350 mm and 450 mm.

A toilet seat should be installed. The minimum internal dimensions of an oval seat are 310 mm and 250 mm and for a round seat the diameter is 250 mm.

The opening in the seat should be smaller than the opening in the pedestal with an overlap of at least 10 mm at the front end side and at least 70 mm at the back.

The surfaces of the toilet seat and lid should be smooth and free of obstructions.

The hinges of the seat and lid should be corrosion-resistant.

A gap should be provided between the seat and lid for ventilation purposes.

16.5.7 Superstructure

The superstructure can be rectangular shaped, circular or spiral with or without a privacy wall (a screen wall makes a door unnecessary).

The design of the superstructure should ensure privacy, comfort and protection against the weather.

The design of the superstructure should allow for emptying the pit, if required. (manually or by vacuum).

To reduce load on the cover slab, pit collar or lining, the superstructure can be offset. Any part of a wall that extends beyond the edge of the cover slab should be supported by a foundation.

The vent pipe may be situated inside or outside of the superstructure.

While the superstructure should allow indirect light to enter, the pit should be kept dark.

The superstructure should be adequately fastened to the cover slab or the foundation.

The roof should be waterproof and adequately fastened to the walls.

The vent pipe should be adequately fastened to the superstructure.

If the door opens outwards it is more prone to wind damage but the interior floor area can be decreased, thus reducing building costs.

The minimum dimensions of a superstructure should be as given in table 2.

The walls and roof can be constructed from a variety of local or prefabricated materials that are durable and weatherproof.

16.6 Ventilation

16.6.1 General

Moving air should be allowed to enter the superstructure through the vent holes through the walls and above the door, through the gap between the lid and seat, through the pedestal into the pit and out through the vent pipe.

Ventilation openings should be provided and positioned high up in the walls or above the door (see Figure 2).

The total ventilation opening areas for incoming air should be at least three times the cross-sectional area of the vent pipe.

16.6.2 Vent pipe

Wind shear across the vent pipe is the main cause of ventilation in the system.

The vent pipe should have a diameter of at least 110 mm.

The vent pipe should extend at least 500 mm above the highest point of the roof.

16.6.3 Fly screen

The vent pipe should be covered with a mesh to prevent flies entering or leaving the pit.

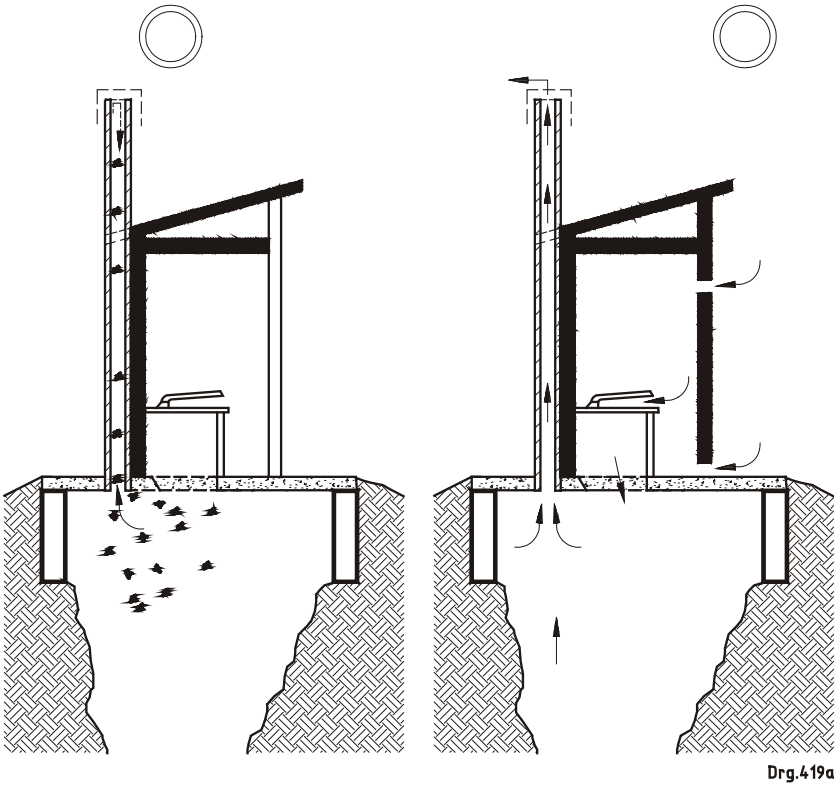
The mesh should be secured horizontally over the top of the vent pipe.

The openings in the mesh should have a maximum size of 1 mm x 1 mm. Smaller openings will cause resistance to free air flow and larger openings allow insects to pass through to the pit.

The mesh should be located in such a position that leaves will not accumulate on it.

The mesh should be made of aluminium, stainless steel, glass fibre or other material resistant to corrosion from uv light, rust and the gases emanating from the pit.

Cowls should not be used over the vent pipe as they obstruct the light and induce turbulence, thereby reducing wind shear at the top of the vent pipe.



a) Fly control **b) Ventilation**

The ventilation systems

16.6.4 Hand-wash facility

Where a water stand pipe is not available nearby a small water tank should be provided.

16.7 Ground water contamination risk associated with a VIP toilet

Unless lined with an impervious lining, on-site sanitation systems, such as the VIP Toilet, dispose of human waste directly into the ground.

In order to minimise the risk of contaminating ground water sources the guidelines provided in the DWAF Ground Water Protocol must be followed.

The DWAF Ground Water Protocol is included in the ***Ground Water Folder***.

TABLE 2: SUMMARY OF RECOMMENDED MINIMUM DIMENSIONS

Component	**Recommended minimum dimensions**	
Pit	Storage volume: Pit to be emptied Toilet to be moved Freeboard:	 2,0 m^3 3,0 m^3 0,5 m
Collar	Depth: Projection above ground level: Slab support width:	500 mm 75 mm 75 mm
Slab	Thickness: Overlap on collar: Reinforcement if span is < 1,5 m: In underside of slab Concrete cover over reinforcement Type: 8 mm bars, 250 c/c each way, or Ref 193 steel mesh, or 4 mm roofing wire, 150 c/c	75 mm 75 mm 25 mm
Pedestal	Height from floor:	350 mm to 450 mm
Seat opening[b)]	Round Oval	250 mm diameter 310 mm X 250 mm
Superstructure[c)] (on site constructed)	Internal height: Internal width: Internal length, door opening outwards: Internal length, door opening inwards: Dimension between pedestal and door opening outwards	1,9 m 0,9 m 1,2 m 2,0 m 0,6 m
Door	Height: Width:	1,5 m 0,7 m
Vent pipe	Diameter: Extending above roof:	110 mm 500 mm
Fly screen	Openings:	1 mm x 1 mm

17 STAFF, HOUSING, LABORATORIES, AND OTHER FACILITIES

17.1 Staff requirements for water supply schemes

Once a scheme has been planned and the basic designs of the various components are known, a staffing structure must be developed. This will depend on the nature of the works (i.e. water or sewage) and on the components which are to be operated and maintained. Staff within the operating organisation who have spare capacity must be kept in mind so as not to burden the organisation unnecessarily.

The components for which staff must be considered are:

- The raw water source, i.e. borehole(s), dam, river pump station, and pipelines.
- The treatment works.
- The main distribution system and reservoirs.
- Reticulation**.**
- Laboratory.
- Stores.
- Administration.
- Meter reading, billing and collecting revenue.

Where a borehole, fitted with a hand pump or a windmill, is provided and user ownership resides in the community, individual members of the community will have to operate the pump as they require water. In the case of the windmill a few people can be responsible for monitoring tank levels and releasing or applying the brake when necessary. Someone within the community needs to be trained to service the pumps/windmill at regular intervals or these services should be provided from outside.

Where one or more boreholes equipped with an engine are involved a permanent "operator" is required to monitor reservoir levels, start and stop the engine, check fuel, oil and water levels, generally ensure the well-being of the engine, procure the fuel and call for specialised maintenance when needed.

In a case similar to the above where chlorination is applied the operator should receive additional training in controlling the chlorination system.

Where water is abstracted from a river, chlorinated and pumped to a reservoir from where it is reticulated to the community an operator will be necessary with appropriate training in pumps diesel/petrol engines or electric motors. Depending on the length of pipelines

and extent of the reticulation, number of standpipes etc. an additional person may be needed to help with maintenance.

Any water supply scheme/or sewage disposal system where a treatment works as defined in the Water Act forms part of the system will fall under Regulation R2834 of 1985 and such works will have to be registered with DWAF and will have to employ operators of the requisite grading. These regulations are included in the ***Legislation and Policy Folder***. These regulations only stipulate the minimum number of operators needed to meet the law. In every case this minimum must be compared with the number of operators physically required to man the works at all times during its operation. Where any works is to operate continuously, for example, at least 4 operators will be required to allow for days off and sick and vacational leave. Besides the operating staff for the treatment process, additional operating staff for dams and pump stations etc., as well as maintenance staff may be required. Depending on the overall length and diameters of the pipelines involved the number and size of maintenance teams will need to be decided. It is recommended that there be at least 1 team per 10 km of pipeline with the size of teams as follows:

DIAMETER OF PIPE	**SIZE OF TEAM**
<75mm	2
75 - 100mm	3
100 - 300mm	4
300 - 800mm	5
>800mm	6

The amount and type of equipment installed will dictate whether full time mechanical and electrical artisans need to be employed or whether such services can be contracted out.

The extent of the buildings and structured will determine the number of civil maintenance staff needed and the number of cleaners needed.

The size of the treatment plant and complexity of the process employed will determine whether full time laboratory staff are required. Usually they would only be necessary on a Class "B" or higher works.

As the size of a treatment plant and/or the major pipelines and reticulation increases, so does the number of supporting staff. Stores are of major importance and a Class "C" or higher works should be provided with a storeman.

Where billing and tariff collection is to be the responsibility of the scheme itself, provision must be made for meter readers (when meters are installed) and for clerks and a cashier.

Financial arrangements need to be made with the WSA to facilitate payments for fuel or electricity and chemicals.

17.2 Housing requirement for water supply schemes

The necessity of providing housing for a scheme will depend on the following:

- Location of works and distance from town.
- Type of storage, water care and pumping facilities and whether they require constant attention.
- Existing staff of service provider and where they are housed.

At the smaller water supply schemes, i.e. those involving boreholes, pumps and chlorination only, and where the level of skill required for the operation and maintenance can be found within the community, housing associated with the scheme should not be necessary.

At larger schemes, where skills required cannot be found within the community to be served and where skills must therefore be procured from elsewhere, consideration must be given to providing housing for the staff required to perform certain duties such as process control, skilled electrical and mechanical maintenance and computerized billing systems.

The houses will need to be similar in size and finish to the standards expected by persons of the relevant post grading. Generally, however, it is preferable to minimize the different types of housing. This reduces housing related problems when personnel are transferred or promoted.

Where housing is provided, problems may arise in cases where it is necessary to terminate the services of employees.

Geographical aspects can be a reason to provide housing for all staff members, such cases arise where a scheme may be located in an isolated area in order to be near a large dam and where transport infrastructure is minimal.

In all cases where housing is provided, the economies of providing the houses against providing a transport allowance should be considered in conjunction with the inconvenience factors which arise. While providing on site housing is convenient for staff, problems arise in providing schooling for children etc.

A charge is normally levied where housing is provided and should this be regarded as too high it is likely that staff may choose lower standards of housing at cheaper rates, privately.

There may be tax implications (perks tax) for employers who receive free housing.

Providing a subsidy for workers to own their own housing should be seen as preferable as this builds stability in communities.

Consideration should be given to the following:

- The installation of security fencing around the housing.
- The provision of security lighting like street lighting or high-mast lighting.
- The provision of an electricity meter for each house.
- The provision of one or more communal telephones.

17.3 Laboratories, offices and other facilities

Laboratory or on-site analysis of water may be performed as a means of plant and system control or adjustment and as a periodic check on water quality. Routine testing of water is designed to establish that the water is aesthetically acceptable and hygienic. These tests may be carried out with relatively simple equipment, titrations, colour comparison or simple robust instrumentation such as pH measurement.

Any water supply scheme such as a borehole or a river pump station where chlorine is added to the water should be provided with a chlorine test kit and the necessary reagents. The recommended equipment is a Lovibond comparator with a chlorine disc B/40A and DPD tablets.

On a small scheme where lime is added a test kit such as that for chlorine, but with a pH disc and reagents should be provided. Alternatively a simple robust PH meter may be used.

Suitable testing equipment and testing frequency for a small water treatment plant that produces <1M1/d are indicated in the table below:

PARAMETERS	**EQUIPMENT**	**FREQUENCY**	**REMARKS**
PH	PH meter	Daily	If lime is added
Turbidity	Turbidity meter	Daily	If flocculants are added
Colour	Colour comparator	Daily	
Chlorine: Total residual Free residual	 Chlorine comparator	Once a day At least twice a day	When gas chlorine is used. When chlorine tablets or solutions are used.
Flocculation	Laboratory jar stirrer	When necessary	When replacing flocculant with a new one or when the nature of the raw water changes

Conductivity TDS E-coli Total hardness Calcium hardness Magnesium hardness Total alkalinity Sulphates Chlorides Fluorides Nitrates Iron Manganese	These tests can be contracted out or performed by a nearby larger facility.	In accordance with the water quality monitoring schedule.	Alternatively when there is pollution or suspicion of pollution in the area.

Note: Potable water should comply with SANS 241. See Chapter 9 for Water Treatment plants.

Suitable testing equipment and testing frequency for a water treatment plant which produces between 1M1/d and 5Ml/d s are listed in the table below:

PARAMETER	**EQUIPMENT**	**FREQUENCY**	**REMARKS**
PH	PH meter	Daily	
Turbidity	Turbidity meter	Daily	
Colour	Colour comparator	Daily	
Chlorine: Total residual Free residual	Chlorine comparator	Once a day At least twice a day	When gas chlorine is used. When chlorine tablets or solutions are used.
E-coli	Incubator	Weekly	
Conductivity	Conductivity meter	Daily	
TDS	Weighing Balance/Calculations	Weekly	
Total hardness Calcium hardness Magnesium hardness Total alkalinity	Titrations:Burettes	Daily	
Stability test	Calculations	Daily	
Flocculation test	Laboratory jar stirrer	When necessary	When replacing flocculant with a new one or when the nature of the raw water changes.

Sulphate Chlorides Fluorides Nitrates Iron Manganese	These tests can be contracted out or performed by a nearby facility.	Once a month or every two months.	Iron and Manganese may be analysed for on a frequent basis, where these are known to occur. Other specific metals may need to be determined when there are industrial or mining activities in the vicinity.

A complete laboratory as per list below should be provided for a water treatment plant which produces >5M1/d. Support laboratory equipment such as weighing balance, hot plates, filters, vacuum pumps, stirrers and burners will also be required.

PARAMETERS	**METHOD/ EQUIPMENT**	**FREQUENCY**	**REMARKS**
PH	PH meter	Daily	
Turbidity	Turbidity meter	Daily	
Colour	Colour comparator	Daily	
Chlorine Total residual: Free residual	 Chlorine comparator	Once a day At least twice a day	When gas chlorine is used. When chlorine tablets or solutions are used.
E-coli	Incubator	Daily	
Conductivity	Conductivity meter	Daily	
TDS	Weighing balance/ Calculations	Weekly	
Total hardness Calcium hardness Magnesium hardness Total alkalinity	Titrations	Daily	
Flocculation test	Laboratory jar stirrer	When necessary	When replacing flocculant with a new one or when the nature of the raw water changes.
Stability test	Calculations	Daily	

Sulphates Chlorides Fluorides Nitrates Iron Manganese	Turbidity/ Gravimetric Titration Spectrometry Spectrometry Spectrometry Spectrometry	Weekly	Iron and Manganese may be analysed for on a frequent basis, where these are known to occur. Other specific metals may need to be determined when there are industrial or mining activities in the vicinity..

Laboratories, workshops and other facilities should be available at the time of scheme commissioning. Sufficient funds should be allowed in the project budget for the start up costs of these facilities.

17.4 Non-fixed assets

Non-fixed assets such as loose tools, laboratory fittings, and workshop equipment should be provided as part of the implementation cost.

The number of vehicles needs to be determined carefully according to the requirement and sharing possibilities.

18 TENDER PROCEDURES

Each Municipality must have their own Tender Procedures. However DWAF Tender Procedures are provided here as a guideline.

18.1 Limitations

This section applies mainly to Civil Contracts, and is only applicable to tenders for new schemes being controlled by the Department of Water Affairs and Forestry.

For Mechanical/Electrical Contracts the Mechanical/Electrical Engineering Directorate must be consulted.

Where State Funds are involved, the Departmental Tender Procedures as prescribed in the Accounting Officer's Procurement Procedures must be used.

18.2 Steps in the tendering process

The tendering process comprise the following steps:

- Approval of Business Plan.
- Detailed survey work starts.
- Detailed design work starts.
- Conceptual Design Report submitted to DWAF Pretoria.
- Design Meeting: consultants meet with DWAF Pretoria design team.
- Update on Conceptual Design Report.
- Draft Tender documents with drawings (3 copies prepared and forwarded to DWAF Pretoria).
- Update Tender Documents: 13 copies plus marked up draft sent to DWAF Pretoria.
- Approval: Original Tender Documents sent around to relevant officials of DWAF Pretoria for signature.
- Original copy plus 12 other copies sent to Departmental Control Committee for approval.
- Call for tender advertised in Government Tender Bulletin (Friday). Advertisement period should be 28 days.
- Tenderers obtain Tender Documents from Tender Office situated at the entrance of zwaMadaka Building.
- Compulsory site visit.
- Contractors calculate prices, fees and total cost of their bid for constructing the project.

- Sealed tenders submitted before due date. Tenders up to an unlimited amount close at the Department.
- Tender box closed at specific time (Wednesday at 11h00).
- Tender box opened in public and details of tenders received recorded.

Adjudication of tenders by consultant.
Submission of Adjudication Report to RDP coordinator.
Adjudication Report accepted and contractor assigned to project.
Contractor starts work.

18.3 Pre- tender stage

The pre-tender stage includes all work up to the submission of the tender documents for approval by the Regional Tender Committee or the Departmental Control Committee, as appropriate.

This stage includes:

- Preliminary proposals (dealt with under Section C: Civil Design).
- Design Reports (dealt with under Section C: Civil Design).
- Draft Tender Documents.
- Final Tender Document.
- Drawings (dealt with under Section C: Civil Design).
- Tender Procedures.
- All reviewed and approved by Directorates: Civil Design and Mechanical/Electrical Engineering as appropriate.

18.4 Draft tender documents

18.4.1 Compilation of draft tender document

All tender documents must be prepared in English.

It is recommended that Consultants familiarize themselves with the general requirements of the General Conditions of Tender, Contract and Order.

On completion of the designs, unless otherwise specified, two draft copies of the tender document, based on the standard DWAF format for either:

- supply/ or installation only, or
- supply, installation and commissioning of mechanical/electrical/civil plants,
- are to be submitted to the Director: Civil Design or M/E Engineering for his comments and approval.

The General Conditions of Contract as amended from time to time are applicable. Civil Design and Mechanical/Electrical Engineering must be consulted to determine which general conditions are applicable.

Various standard forms and specifications as indicated in the standard DWAF format, are to be included in the tender documents, i.e.:

- Special conditions of contract which should not be altered or modified by the Consulting Engineer without the approval of the Department.
- Preference should be given to the use of South African National Standards (SANS) as drawn up by the South African Bureau of Standards.
- Penalties or damages must be determined as described in the General Conditions of Contract and or Clause 32.5.2 of the General Conditions of Tender, Contract and Order. For smaller contracts the formula gives and insignificant amount and the penalty must be determined in collaboration with the Director: Civil Design or M/E Engineering and Sub-directorate: Contract Administration. When valves for example are supplied under a separate contract for a pipeline, reservoir, etc., late deliveries can have a significant influence on the construction and completion of the contract. If the late completion of the contract may result in claims from other Contractors against the Department, this must be taken into consideration when determining the penalty.

18.4.2 Standard format of a DWAF tender document

The standard format of a Departmental tender document is provided below. The consultant may rearrange the format:

- DWAF Tender Front page (DW 106)
- Invitation to Tender (C2)
- Tax Clearance Certificate (C3)
- Locality Plan
- Notice of Site Inspection
- Site Inspection Certificate
- Instructions to Tenderers
- Form of Tender
- Appendix
- Important Conditions: Miscellaneous Requirements (C 6)
- Tender Commitment form (C4)
- Form Preference Points Claim: General Conditions and Definitions (C9) **Compulsory**
- Form Preference Points System: (C9.1, C9.2)
- Form Preference Points System: Equity Ownership by HDI's (C9.6) **Compulsory**
- Form Preference Points System: Procuring Locally Manufactured Products (C9.7)

- Form Preference Points System: The Promotion of Small Businesses (C9.8)
- Declaration of Interest (C10)
- Questionnaire (C8)
- Credit Order Instruction (C11)
- Agreement
- Deed of Suretyship
- Schedule of Similar Work Undertaken by Tenderer
- Schedule of Proposed Sub-Contractors
- Special Conditions of Contract
- Alterations by Tenderer
- Project Specification (Including Project Manufacture and Installation Schedule)
- Particular Specifications
- Schedule of Quantities
- Daywork Schedule
- List of provisional amounts, for example allowances for escalation.
- The National Industrial Participation Programme (NIPP) [where appropriate for large import content contracts]

18.4.3 Departmental tender and contract forms (C-forms)

The following Departmental Tender and Contract Forms should be included in the tender document:

- Form C2: Invitation to Tender.
- Form C3: Tax Clearance Certificate.
- Form C6: Important Conditions: Miscellaneous requirements.
- Form C4: Tender Commitment Form.
- Form C8: Questionnaire.
- Form Preference Points Claim: General Conditions and Definitions (C9) **Compulsory**
- Form Preference Points System: (C9.1, C9.2)
- Form Preference Points System: Equity Ownership by HDI's (C9.6) **Compulsory**
- Form Preference Points System: Procuring Locally Manufactured Products (C9.7)
- Form Preference Points System: The Promotion of Small Businesses (C9.8)
- Form C10: Declaration of Interest.

Credit Order Instruction (C11)

Original copies of the C forms can be obtained from the Tender Office situated at the entrance of zwaMadaka Building and may not be retyped.

18.4.4 Departmental formats

The following Departmental Formats are available and should be included in the Tender Document:

- Instructions to Tenderers (The Consultant may add additional instructions).
- Special Conditions of Contract and its Appendix.

18.4.5 Standard proformas

The following proformas should be the standard pro forma forms of the "General Conditions of Contract 1990".

- Alterations by tenderer.
- Tender.
- Agreement.
- Deed of Suretyship.

18.4.6 Other proformas

The following should be included in the contract document:

- Preamble to the Schedule of Quantities.
- Daywork Schedule.
- Schedule of Proposed Sub-Contractors.
- Schedule of Similar Work.

The Consultant may use his own forms or the Standard forms of the Department.

No allowance for price variation or contingencies may be included in the tender.

Amount of Suretyship (Civil Contracts)

The following is recommended:
For contracts with a value in excess of R5 million the amount of suretyship shall be 10%.
For contracts with a value equal to R3 million, but less than R5 million the amount of suretyship shall be as follows:
The greater value of:
Value of fixed charge and value related items in Schedule of Quantities
Or
If value of contract is R150 000 or less: 0%
If value of contract is more than R150 000 but less than R1 million: 2,5%
If value of contract is more than R1 million but less or equal to R3 million: 5%
If the value of the contract is more than R3 million but less than R5 million: 6% - 10%

18.4.7 Final tender document

After incorporation of the comments of the Department into the final document, thirteen copies shall be forwarded to the Tender Office, under cover of a letter which must also give the total estimated cost of the contract, together with expected expenditures for each financial year.

An advertisement, completed on the standard Departmental form, giving the date of advertisement, details of the site inspection, deposit to be paid by the Tenderers for a set of documents, closing date of the tender, etc. must also accompany this letter.

The following deposit structure is recommended:

the invitation of tenders above R150 000, 00 and up to R500 000, 00 a non-refundable deposit will be R50, 00;
between R500 000, 00 and up to R1 million a non-refundable deposit of R100, 00; and
for the invitation of tenders in excess of R1 million a R200, 00 non-refundable deposit.

Please note that no tender deposits are allowed on the invitation of price quotations up to R150 000, 00 per case as well as on the invitation of proposals for professional services.

The date of the site meeting for major civil and building contracts shall be arranged in consultation with the office of the South African Federation of Civil Engineering Contractors or the Master Builders Association in the case of building contracts.

18.5 Tender procedure

Approximately two weeks after the tender document has been approved for publication by the Departmental Control Committee, the tender will be advertised in the Government Tender Bulletin. If required, advertisements can also be placed in the press. Tenders must close at the appropriate DWAF office.

Tender documents will only be issued by the tender section of the Department on payment of the prescribed non-refundable deposit.

18.6 Tender stage

The tender stage includes all work from the advertisement of the tender until the issue of the order.

18.6.1 Site inspection

All information, clarification of clauses in the documents given by the Consultant and questions lodged by any tenderer at the site inspection, together with the answers, shall be recorded and sent to all tenderers as an addendum. It is to be stated clearly that the above will form an integral part of the tender documentation and tenderers must sign acceptance thereof and submit the said addendum together with their tenders. The addendum must be approved and counter signed by the Regional Director before it is distributed to the tenderers. Any other addendums shall be distributed in the same manner and must also be included in the tender. All addendums will be regarded as an integral part of the tender document.

18.6.2 Extension of tender period

Before granting and extension to the tender period it shall be discussed with and approved by the Tender Section, who will then inform the Government Tender Bulletin in writing of the new closing date of the tender. Consulting Engineers shall then advise the tenderers in writing by means of a telex or fax of the new closing date. Clause 12.4 of the General Conditions of Tender, Contract and Order must be adhered to.

18.6.3 Adjudication of tenders

After the closing of the tenders, the Tender Office will forward the tenders to the Regional Director. A duplicate copy of the tenders plus all correspondence shall be collected by hand from the Regional Director by the Consulting Engineer.

Consulting Engineers may not obtain any additional prices or rates from any tenderer during the adjudication period. Communication, except for technical clarification, with the tenderers should be avoided, and then only with the approval of the Regional Director.

The Consulting Engineer must submit a detailed report recommending, with full motivation, the acceptance of a tender as soon as possible, but not later than three weeks after receipt of the tenders from the Department. This recommendation plus all copies of the tenders including the correspondence shall be returned to the Regional Director, by hand.

The report shall include a Schedule of Tenders with comparative prices and a technical summary of the offers received.

18.6.4 Acceptance of a tender

Based on the Consultant's report the Department will check for any discrepancies between the "ORIGINAL" and "DUPLICATE COPY" of the tenders and draw up and submit a recommendation to the appropriate committee for approval. The Departmental Control Committee meets once per week, on a Monday at 12h00. Recommendations and/or specifications which must serve before the DCC must reach the Tender Office not later than a Wednesday at 12h00. When the tender recommendation has been approved, the Tender Office will send a Letter of Acceptance (C17) to the successful Tenderer. The Consulting Engineer will be advised and the official tender order will subsequently be issued by the Regional Director.

The "Tender" becomes a "Contract" with the letter of acceptance.

Rejection of all tenders or cancellation, but before approval by the DCC/RTC

A recommendation to reject all tenders or to cancel the tender must be referred to the relevant Director for approval of the cancellation.

18.6.5 Sureties and insurances

The sureties or guarantees and insurance policies that must be provided by the Contractor in accordance with the General Conditions of Contract and Clause 45 of the General Conditions of Tender, Contract and Order shall on receipt thereof from the Contractor, firstly be checked for correctness, and then sent to the Regional Director.

18.6.6 Signing of the contract

For all major contracts the "Form of Agreement" must be signed in duplicate by the Contractor and relevant Managing Engineer of the Department on behalf of the Employer.

Two documents must be book bound for signature. Only the agreement must be signed. It is not necessary to initial each page.

18.6.7 Award meeting

Immediately after the award of a contract the Consulting Engineer must arrange a meeting between responsible representatives of the Employer, the Consulting Engineer and the Contractor to clarify the scope of the contract and matters of procedure and to hand over the site to the Contractor.

18.7 Mechanical tender preparation guidelines

18.7.1 Document preparation - broad outline

Mechanical tender documents shall comprise the following in broad outline:

General specification relating to components, items and services which generally occur in pump stations, including the crane or hoist.

Project specification describing the specific project first in general terms and then in specific detail.

Technical schedule similar to the Bill of Quantities, but limited to specifying and/or inquiring of the tenderer only the technicalities of the equipment offered.

Form of Guarantee relating to pump, motor and pumpset performance.

Price schedule comprising tender price broken down into just a few major groupings and detailed items as deemed necessary for financial control of the contract.

Note:

The Mechanical engineering component of a pump station contract, unlike its Electrical and Civil engineering counterparts, does not employ a Bill of Quantities because very little of the equipment offered is of a repetitive or "measured" nature. It is not necessary to cost out each little pipe piece or nut, bolt and gasket.

Furthermore, a "payment by progressive measurement" of works completed by month end is not a meaningful control device. A method of payment against measurable goals achieved and relating to specific items of equipment as highlighted in the original document price schedule is employed. Progress payments per item are limited to up to 80% of tender value when delivered to site, with a further 10% making up 90% of both item cost and installation when equipment is ready for commissioning. Successful commissioning initiates the Guarantee Period (either 12 or 24 months). The final 10% of

Contract Value is withheld as retention money and may be released only after the satisfactory completion of the Guarantee Period, signaled by the Final Certificate.

A "Performance Bond" for 10% of the order value, is held until the Final Certificate is issued.

18.7.2 Specific points to be noted

The pump and motor (the pumpset mounted on a single baseplate) are costed in the same schedule and are considered to be a single entity.
The pump duty and station duty are specified as a primary factor in the compilation of the Project Specification - not hidden somewhere in a bill of quantities.
No specific pump manufacturer, pump size or model may be assumed. The specification must therefore clearly define how the motor is to be sized with at least 15% over-capacity safety margin. Pump and motor performance efficiency and power demand shall be guaranteed by the contractor.
Brand names may not be referred to under any circumstances when describing items in the specification. Performance requirements shall be fully specified.
Pump motor, flow meters and any other sensing instrumentation shall be part of the Mechanical Specification.

18.8 Electrical tender

The following must be included in all electrical tender documents issued for CWSS projects.

- No brand names and/or type numbers are allowed.
- The electrical scope and limits of contract must be clearly defined.
- The tenderers must be informed as to how and where the electricity is supplied and metered.
- An electrical and control function analysis must be provided.
- A line diagram of the system must be provided. This must indicate the existing layout as well as that required by the contract.
- One drawing showing the overall electrical earthing system is required.
- The Department's Mechanical and Electrical Engineering Directorate's General Technical Specifications (Electrical) (GTSE) must form part of the document. These are available in printed form as well as on electronic media.
- Transformer and cable sizes must be clearly indicated.
- There must be an electrical project specification that describes the requirements of the tender. This must cover the MV (if any) and LT panels, the motor control center, an earthing system, lighting protection and building power and lights etc. These must be clearly set out to enable the tenderer to select the relevant parts of the GTSE that apply to the contract.
- Only include those sections of the GTSE that applies to the specific project.

18.9 Procurement of a professional team

The latest version of DWAF's Policy for the appointment of Professional Service Providers (PSP's) should be followed. Special attention should be given to the respective fee limitations for competitive bid and tender.

19 CONTRACT ADMINISTRATION

Each Municipality must have their own contract administration systems. DWAF's system is given here as a guide.

19.1 Payment certificates

Payment certificates, certified for payment by the Consultant must be forwarded timeously to the Regional Director who must be consulted beforehand on the payment procedure.

The payment certificate must be structured as set out below and must contain the following information for each item of the schedule of quantities:

- The item number with a short description.
- The unit of measurement.
- The billed quantities.
- The previously measured quantity.
- The quantity for the month.
- The total quantity measured to date.
- The rate of payment.
- The total amount claimed.

All variation orders, day-works claims and extras must be listed and referenced at the end of the certificate.

The certificate must also be accompanied by a summary sheet containing the aggregates of all the individual sections, day-works and variation orders, as well as materials on site, price variation and other miscellaneous items.

An original VAT invoice must accompany all payment certificates.

Actual disbursements should be captured on the Department's Financial Management System. Operating and Capital costs should be recorded separately and not confused with one another.

19.2 Correspondence

Where Consulting Engineers are employed to supervise the construction of works of a civil engineering and building nature or a mechanical/electrical contract executed by a private contractor the following shall apply:

Copies of all correspondence must be forwarded to the Regional Director.
All matters relating to design aspects of the works shall be referred to the Regional Director and copies of correspondence, reports, etc. must be sent to the Regional Director.

19.3 Estimated costs

The following procedure must be followed:

- The estimated cost of the contract together with expected expenditures for each financial year must be submitted to the Department under covering letter with the Final Tender Document.
- After the award of a tender, the Consulting Engineer must submit an estimate of the total value of the contract including all additional costs that can be foreseen at that time, subdivided into annual expenditures if the duration of the contract extends over more than one financial year.
- On larger works where more than one contract is involved, a table setting out the anticipated expenditure for the whole project or works controlled by the Consulting Engineer, must be submitted initially and updated during April of each year. During January of each year an estimate must, after consultation with the Contractors, be made and submitted to the Regional Director, giving the value of the payment certificates for which payment will be required before 31 March of that year.

19.4 Variation orders

For alterations, additions and omissions to the contract the Consulting Engineer shall follow the procedures as set out in the General Conditions of Contract. The following procedures must also be adopted:

The nature and up to what value a variation order may be issued by the Consulting Engineer without prior reference to the Regional Director will be specified in the special conditions of contract. All variation orders must however be referred to the Regional Director for his final approval.

All variation orders involving substantial changes in design or specifications must be referred to the Regional Director. In these instances the Consulting Engineer must obtain

a written quotation from the Contractor and determine whether the price is reasonable before reference to the Regional Director. The quotation and recommendation can be dealt with per facsimile if urgent, but must be followed by the Contractor's original signed quotation. The Consulting Engineer shall not instruct the Contractor to proceed until he has obtained approval from the Regional Director.

All variation orders must be submitted on an approved standardised form and consecutively numbered.

Variation orders must be kept up to date and submitted for approval within one month after occurrence of the event.

19.5 Co-ordination

Since most Departmental projects involve more than one contract as well as works executed Departmentally, regular co-ordinating meetings shall be held between the parties involved with the Consulting Engineers responsible represented. The Consulting Engineers will normally be required to minute all meetings with Contractors and must forward copies to all parties involved including the Regional Director.

19.6 Construction reports

The Consulting Engineer will be required to submit a Monthly Construction Report or Progress Report.

Where dams requiring dam safety regulations are involved or for the larger schemes, proposed pro-forma of the construction report is available from the Chief Engineer: Contract Administration. The reports must be in such a format that at the end of the contract the monthly reports must be in bound together with the final covering report to constitute the Final Construction Report. Under certain circumstances (dam safety requirements) the Engineer will be required to submit a separate consolidated Final Construction Report.

19.7 Inspections

19.7.1 Civil works

General

On completion of a contract, but prior to the issuing of the Certificate of Practical Completion, a joint site inspection shall be held. On completion of the list of outstanding items compiled at this inspection the Consultant may issue the Certificate of Practical

Completion in terms of Clause 54 of the General Conditions of Contract to the Contractor.

At the end of the maintenance period the works shall once again be inspected to establish whether any defects have to be corrected by the Contractor.

These inspections shall be attended by the Contractor and the Consulting Engineer and representatives of the following Directorates of this Department:

- Construction
- Civil Design
- Mechanical/Electrical Engineering
- Water Utilisation
- Regional Office

When it has been established that the Contractor has fulfilled all his obligations in terms of the contract, the "FINAL APPROVAL CERTIFICATE" may be issued in terms of Clause 55 of the General Conditions of Contract and the last retention monies released.

Dams

The behaviour of the dam structure and ancillary works shall be monitored during the construction and during the first filling as required by the Director: Civil Design.

Mechanical and electrical works

The following procedure shall be adopted:

While commissioning is in progress, the Contractor in conjunction with the Consulting Engineer will be expected to train the Water Services Provider's (Water Board or Local Government) staff in the normal operation of the plant installed. The training shall be done with the aid of operation and maintenance manuals which shall be compiled and provided by the Consulting Engineer and/or the Contractor as required by the Director: M/E Engineering.

When commissioning has been satisfactorily achieved, acceptance tests on site will be carried out by the Contractor, in the presence of the Consulting Engineer and representatives of the Water Services Provider (Water Board or Local Government), the Regional Director and of the Mechanical/Electrical Engineering, Civil Design and Water Utilisation Directorates.

The Engineer will subsequently recommend that the plant be taken over from the Contractor, by way of a commissioning certificate whereby the Water Service Provider (Water Board or Local Government) also agrees to be responsible for the operation of the plant. At this time the guarantee period (normally twelve months) commences during which period the Contractor must meet any outstanding obligations.

Prior to the expiry of the guarantee period, an on-site inspection will be held where the Consulting Engineer, the Contractor, the Water Services Provider (Water Board or Local Government) and the Directorates: Mechanical/Electrical Engineering, Civil Design and Water Utilisation and the Regional Office will be represented. When it has been shown that the Contractor has fulfilled all his obligations, the Final Certificate must be issued together with the release of the last retention monies.

20 REPORTING ON OPERATIONS

20.1 Annual scheme audit and water balance

The Regulations prepared in terms of S9 of the Water Services Act require a Water Services Authority to include a water services audit in its annual report on the implementation of its water services development plan. The annual report on the WSDP is required in terms of section 18(1) of the Act.

The Regulations also require a Water Services Authority to undertake an annual water balance every month.

The S9 Regulations are included in the Legislation and Policy Folder.

21 CONTENTS OF FOLDERS

21.1 Legal and policy folder

- Constitution of the Republic of South Africa, 1996(Act 108 of 1996)
- Water Services Act, 1997(Act 108 of 1997)
- National Water Act, 1998(Act 36 of 1998)
- Municipal Systems Act, 2000(Act 32 of 2000)
- Municipal Structures Act, 2000(Act 33 of 2000)
- Public Finance Management Act, 1999(Act 1 of 1999)
- Local Government Municipal Finance Management Act, 2003 (Act 56 of 2003)
- Division of Revenue Act-Enacted Annually
- Strategic Framework for Water Services, September 2003
- White Paper on Sanitation, September 2001
- Regulations under S9 of the Water Services Act, 1997
- Regulations under S10 of the Water Services Act, 1997
- Regulations under S 19 of the Water Services Act, 1997
- Model Water Services Bylaws. Section 21(1) of the Water Services Act, 1997

21.2 Institutional folder

- Terms of reference (TOR) for assessing Water Services Provider options under S78 of the Municipal Systems Act
- Model Water Services Contract between DM and LM

21.3 Planning folder

- WSDP preparation guide

21.4 Design specifications folder

- See Design Specifications Section for full list

21.5 SANS folder

- SANS specification numbering list

21.6 Drawing folder

- BOT Drawings
- Standard Drawings

CAD software is required to read these drawings.

21.7 Procurement folder

- DWAF Policy for the Appointment of Professional Service Providers
- DWAF Accounting Officer's procurement procedures
- Government Procurement: General Conditions of Tender, Contract and Order

21.8 Sanitation folder

- Farm Dweller Sanitation: Guidelines for implementation

21.9 Ground water folder

- Ground water protocol