WATER AND SANITATION DEPARTMENT

GUIDELINES AND STANDARDS FOR THE PLANNING AND DESIGN OF WATER AND SANITATION SERVICES

March 2020

Version: Final

DOCUMENT HISTORY AND VERSION CONTROL

Version Number	Date Adopted	Approved By	Brief Description
1	15 June 2006	Water Services Planning Forum Members	Developer's Guidelines to Installing Water and Sewer Services in Ekurhuleni
2	17 June 2019	Workshopped: Water Services Planning Forum Members	Guidelines and Standards for the Planning and Design of Water and Sanitation Services

RECORDS OF REVISIONS AND AMENDMENTS: DESCRIPTION

Sections	Title	Revision No.	Amendments No.	Page Number(s)
All	Guidelines and Standards for Planning and Design of Water and Sanitation Services	7	As per Planning Division workshop	All pages

It should be noted that this document will be reviewed and revised on a regular basis by the City of Ekurhuleni Standards Committee.

CONFIRMATION

City of Ekurhuleni Guidelines and Standards for Planning and Design of Water and Sanitation Services , September 2019 Version: was adopted and approved by the Water and Sanitation Department.

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City of Ekurhuleni

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NOMENCLATURE

AADD	Average Annual Daily Demand
ADWF	Average Dry Weather Flow
BOD	Biochemical oxygen demand
COD	Chemical oxygen demand
CoE	City of Ekurhuleni
CV	Curriculum Vitae
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
EMF	Electromagnetic flow
EMP	Environmental Managmet Plan
FC	Fibre Cement
GRP	Glass Reinforced Plastic
HDPE	High Density Polyethylene
IPF	Instantanious Peak Factor
IWA	International Water Association
JASWIC	The Joint Acceptance Scheme for Water Services Installation Components
KPA	Key Performance Area
KPI	Key Performance Indicator
MNF	Minimum Night Flow
NRW	Non Revenue Water
PE	Polyethylene
P&G's	Preliminary and General
PF	Peak Factor
PVC	Polyvinyl chloride
RW	Rand Water
SABS	South African Bureau of Standards
SANS	South African National Standards
SIV	System Input Volume
SPF	Summer Peak Factor
TOC	Total organic carbon
UFW	Unaccounted for Water
WCWDM	Water Concervation and Water Demand Management
WTW	Water Treatment Works
WUL	Water Use Licence
WWTW	Wastewater Treatment Works

1 GENERAL BACKGROUND AND REQUIREMENTS

1.1 Introduction

The procedures in this document provide the Guidelines and Standards to be adhered to in all developments for the design, construction and maintenance operations of water and sewerage networks and associated infrastructure, operated and maintained by the City of Ekurhuleni (CoE). Where special circumstances necessitate a deviation from the guidelines and standards, the proposed deviation must be referred to the Divisional Head: Water and Sanitation – Planning Division for approval before implementation.

The Guidelines are divided into the main document with the following annexures:

- Annexure A: Submission and approval of design documents and drawings
- Annexure B: Material standards
- Annexure C: Standard Guideline Drawings
- Annexure D: Water reclamation for industrial use
- Annexure E: Infrastructure applicable to water and sanitation services
- Annexure F: Water conservation and demand management measures

1.2 Design Codes and Standards

The design of water and sanitation services infrastructure within the CoE must comply with the requirements of the latest editions of the following Codes, Standards and Statutory Regulations, amongst others:

- The South African Bureau of Standards (SABS) / South African National Standards (SANS)
- Guidelines for human settlement planning and design (Red Book)
- SANS 10100: The structural use of concrete
- SABS 0162-1: The structural use of steel
- SANS 10160: The general procedures and loading to be adopted in the design of buildings
- SANS 1200: Standardized Specification for Civil Engineering Construction
- BS 8007: 1978 – British Standard Code of Practice for Design of Concrete Structure for Retaining Aqueous Liquids
- SANS 1936: Development on dolomite land

1.3 Submission and approval of design documents and drawings

The following documents must be submitted to the Divisional Head: Planning Division for review and approval before –

- commencing with the next project stage; or
- commencing with the construction of new works; or
- taking over of private developments CoE.

The reports and drawings must be signed by a professional Engineer or Technologist (Pr Eng. or Pr Tech Eng.), registered in terms of the Engineering Profession Act, 2000 (Act No. 46 of 2000).

- ***Feasibility Study Report*** – the Report must be based on the masterplan, must address land matters and servitudes, must address possible Rand Water connection requirements, and be submitted to Divisional Head: Planning Division

- ***Concept & viability (Inception / Scoping) Report*** – the Report should be in accordance with Section 4.1 of **Annexure A** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services". The Chief Area Engineer should confirm the scope of work and the challenges of the region
- ***Preliminary Design Report*** – the Report should be in accordance with Section 4.1 of **Annexure A** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services". It should outline the full extent of the project, alternatives and proposed engineering solutions, associated costs and impact on the environment
- ***Design Development (Detail Design) Report*** – the Report should be in accordance with Section 4.1 of **Annexure A** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services". The Repor should outline the project background, preliminary investigations, design methodology, design calculations and results, comparisons of alternatives, risk managements, associated cost, drawings, operation and maintenance plans and manuals amongst others
- ***Wayleaves Applications*** – wayleave approvals from all service providers must be obtained before the Design Development (Detail Design) Report will be approved
- ***Documentation and Procurement*** – for procurement of internal capital projects, use latest CoE template of Tender Document must be made. It must conform to the CIDB's Standard for Uniformity in Construction Procurement policies and be submitted to CoE **one (1) month** prior to advertisement;
- ***Construction Drawings*** – drawings should be in accordance with Section 4.2 of **Annexure A** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services". It must be approved by CoE prior to commencement of construction

1.4 Take – over of Works after completion

The new services installed by the service providers will only be taken over by CoE after –

- ***Proclamation of the development / township.*** Refer to **Annexure A** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".
- ***All inspections have been carried out to the satisfaction of the relevant CoE Water and Sanitation Divisions*** (including the relevant completed & signed inspection sheets)
- ***Submission of As-built drawings, Close-out Report and Completion Inspection Report.*** These documents shall be submitted within one month after project completion. Refer to **Annexure A** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".
- ***Submission of Asset Capitalisation Certificate and final Bill of Quantities***. The Certificate shall be completed and submitted together with final accounts / final payment certificates.
- ***Submission of Operation and Maintenance Manuals.*** . Refer to **Annexure A** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

2 WATER RETICULATION

2.1 General requirements

This Section covers the planning and design of water reticulation and trunk/mains (bulk) pipelines.

Water reticulation for residential, industrial and commercial development shall be implemented in accordance with the guidelines and standards in this document within the road reserve of a public road or within a servitude registered for this purpose in the name of CoE.

All work (pipes, valves, fittings, hydrants, chambers etc.) must comply with CoE standards and drawings as per **Annexure C** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

Upon completion of the project, the water reticulation infrastructure shall be inspected by the relevant Water and Sanitation – Division. Once approved, and the required documentation as specified in paragraph 1.4 are submitted, the ownership and maintenance of the infrastructure will be taken over by Water and Sanitation – Operations Division. In case of a private development, CoE will only take-over the operations and maintenance responsibility of infrastructure from the developer (including connections) upon proclamation and / or registration of a subdivision, where applicable.

Where Municipal water pipelines cross private properties and the pipelines are not protected by servitudes in terms of the conditions of establishment / township, the registration of servitudes in favour of the CoE will be required, at the cost of the Applicant.

The design of water reticulation systems shall ensure sufficient capacity for the type of development proposed. The proposed system shall be designed to integrate with existing and future developments and provide a water connection at the street front of every erf.

The design of each development's water reticulation system has to be submitted to the CoE for incorporation into their overall water supply system. A hydraulic modelling analysis must be submitted for each development, in order to evaluate and properly develop existing water sources and distribution systems.

The CoE considers trunk / link / bulk water pipelines to be 250 mm in diameter and larger. Average velocities should be ± 0.6 m/s and not exceed 1.5 m/s. Bulk pipelines shall have parallel distribution mains in order to supply water for service connections. No house connections will be allowed on bulk pipelines. Bulk pipelines shall not be located in narrow residential roads.

The works shall comply with SANS 1200 unless otherwise specified in this Guideline document or per specific conditions of the tender document.

A detailed site investigation must be undertaken to establish the location of all existing infrastructure and affected services to facilitate the design of the water reticulation. Plans and records of these services must be obtained from the relevant service providers and approval must be obtained when their services are affected. A layout plan indicating the location of all existing services in relation to the planned location of new services must be submitted to the relevant CoE division for approval.

2.2 Design guidelines

2.2.1 Unit demands for master planning

During the planning and design stages of a development, formalised site layout plans or specific land uses might not be readily available. Use of **Table 1** must therefore be made to calculate average annual daily demands (AADD) for long-term water master planning purposes or until layout plans or specific land uses have been finalised.

Table 1: Summarised Planning Standards for AADD

LAND USE	TYPICAL DENSITY (erven/ha)	GUIDELINE AADD (kℓ/ha/day)
Residential I	10	12.00
Residential I and II	20	18.00
Residential III	40	25.00
Residential IV	60	30.00
Residential IV	80	32.00
Residential IV	100	40.00
Residential IV	120	48.00
Agricultural Holding	1	4.00
Business/Commercial	0.4 FAR [1]	32.00
Industrial	0.6 FAR [1]	24.00

[1] FAR – Floor Area Ratio

Demand values reflected in **Table 1** excludes unaccounted for water (UFW) which can be calculated at 20%.

2.2.2 Unit demands detail engineering design

Unit demands for detail engineering design **Table 2** must be made to calculate AADD during detail design, when layout plans or specific land uses have been finalised.

Table 2: Design Standards for AADD

ITEM	ZONING	UNIT/DAY	WATER CONSUMPTION
1	**RESIDENTIAL**		
1.1	Low-cost housing – erf up to 500 m²	kℓ per erf	0.7
1.2	Conventional small sized erf up to 500m²	kℓ per erf	0.8
1.3	Medium sized erf 501m² - 1000m²	kℓ per erf	0.8
1.4	Large-sized erf 1 001 m² up to 1 500 m²	kℓ per erf	1.0
1.5	Extra-large erf 1 501 m² and larger	kℓ per erf	1.5
1.6	Cluster housing up to 20 units per hectare (Res 2)	kℓ per unit	1.0
1.7	Cluster housing 21 up to 40 units per hectare (Res 3)	kℓ per unit	0.8
1.8	Cluster housing 41 up to 60 units per hectare (Res 4)	kℓ per unit	0.6
1.9	Cluster housing 61 up to 80 units per hectare (Res 4)	kℓ per unit	0.5
1.10	Cluster housing 81 up to 100 units per hectare (Res 5)	kℓ per unit	0.4
1.11	High-rise flats (± 50 m² per unit) according to FSR	kℓ per 50 m²	0.6
1.12	Boarding houses, hostels, hotels, retirement centers & villages, orphanages	kℓ per 100m²	0.9
1.13	Guesthouses - allocation per room regardless of room size	kℓ per room	0.4
1.14	Agricultural holdings & farm land (connection for domestic use only)	kℓ per domestic unit	2.4
1.15	Agricultural holdings (house + servants quarters + garden) (to be used only for subdivisions to create multiple holdings)	kℓ per holding	4.0
1.16	Gate house for security villages	kℓ per unit	0.2
2	**BUSINESS DEVELOPMENTS**		
2.1	General business with an FAR (dry)	kℓ per 100m²	0.8
2.2	General business with an FAR (wet)	kℓ per 100m²	1.2

ITEM	ZONING	UNIT/DAY	WATER CONSUMPTION
2.3	Business and offices	kℓ per 100m²	0.6
2.4	Gym, health spa	kℓ per 100m²	0.6
2.5	Commercial	kℓ per 100m²	1.0
2.6	Restaurant, bakery	kℓ per wash bay	1.0
2.7	Butchery	kℓ per 100m²	0.2
2.8	Warehousing (including up to 20% offices)	kℓ per 100m²	0.6
2.9	Garage or filling station	kℓ per 100m²	1.2
2.10	Car wash facility (no recycling)	kℓ per wash bay	6.0
2.11	Car wash facility (with recycling plant)	kℓ per wash bay	3.6
2.12	Motor city / Retail park as a single zoning (car sales + limited offices)	kℓ per 100m²	0.6
2.13	Vehicle parking garage/grounds	kℓ per bay	0.0
2.14	Nursery (sales area)	kℓ per 100m²	0.4
2.15	Nursery (planting and production area)	kℓ per hectare	15.0
3	**INDUSTRIAL DEVELOPMENTS**		
3.1	Industrial (dry)	kl per 100m²	0.5
3.2	Industrial (wet)	kl per 100m²	min of 1.2 kl
4	**INSTITUTIONAL USES**		
4.1	Club buildings	kl per 100m²	0.3
4.2	Club grounds	kl per hectare	3.0
4.3	Stadium building	per 1 000 people	1.5
4.4	Stadium grounds	kl per hectare	3.0
4.5	Municipal park buildings	kl per 100m²	0.4
4.6	Municipal park grounds	kl per hectare	3.5
4.7	Hospital buildings without laundry	kl per 100m²	1.54
4.8	Hospital buildings with laundry	kl per 100m²	4.2
4.9	Hospital grounds	kl per hectare	10.0
4.10	Church buildings	kl per 100m²	0.1
4.11	Church grounds	kl per hectare	10.0
4.12	School, crèche, educational buildings	kl per pupil	1.5
4.13	School, crèche, educational grounds	kl per hectare	1.5
4.14	Municipal, governmental developments	kl per 100m²	1.0
5	**MISCELLANEOUS USES**		
5.1	Mixed use	kl per hectare	20.0
5.2	Private open space	kl per hectare	15.0
5.3	Special (Development specific)		Development specific
5.4	Home enterprise (dry, office, IT)	kl per 100m^2	0.4
5.5	Home enterprise (wet, tavern, hairdresser)	kl per 100m^2	0.8

[1] FAR – Floor Area Ratio

[2] Water demand excludes unaccounted water (UFW) @ 20%.

[3] The calculation should be based on the potential area or number of units being applied for.

2.2.3 Peak demand factors and flow velocity

The following equations should be used in calculating peak demands:

1. Summer peak demand: Summer peak factor (SPF) x AADD
2. Instantaneous peak demand: Instantaneous peak factor (IPF) x AADD

Table 3: Peak Flow Factors

PREDOMINANT LAND USE	AADD (kℓ/day)	SUMMER PEAK FACTOR	INSTANTANEOUS PEAK FACTOR
Low-cost housing	< 1 000	1.90	3.60
	1 000 - 5 000	1.80	3.40
	5 000 - 10 000	1.70	3.30
	10 000 - 15 000	1.50	3.20
	15 000 - 20 000	1.40	3.10
	> 20 000	1.40	3.00
Residential	< 1 000	2.20	4.60
	1 000 - 5 000	2.00	4.00
	5 000 - 10 000	1.80	3.60
	10 000 - 15 000	1.60	3.50
	15 000 - 20 000	1.50	3.30
	> 20 000	1.50	3.30
Business / Commercial / Industrial	< 5 000	1.70	3.30
	5 000 - 10 000	1.60	3.15
	> 10 000	1.50	3.00

Table 4: Flow Velocities

PIPES	MINIMUM VELOCITIES	MAXIMUM VELOCITIES
Diameters ≤ 110mm	0.7 m/s	1.0 m/s – 3.5 m/s
Diameters ≥ 250mm	0.6 m/s	1.5 m/s
Feeder pipes to reservoirs	1.2 m/s	2.0 m/s
Special Fittings	-	6.0 m/s

Water systems must be designed and pipe sizes determined in accordance with the standards and engineering principles set out in this document. All water reticulation systems must be designed by means of a computer program that is compatible with **Wadiso** or **Sewsan**, or similar approved by CoE.

All systems must adhere to the following:

- Residual pressures at every erf boundary is **24 m** for residential and **35 m** for industrial/business under peak consumption conditions; and
- The requirements set out in **Table 5** for fire flow under peak flow conditions.

No reticulation system will be approved before the Consultant provides the above design information, as part of the Preliminary Design Report. An electronic copy of the information, assumptions, analyses and results must also be included in the report.

2.2.4 Firefighting demand and pressure

Provision of water for fire-fighting purposes should comply with the requirements of the SANS code of practise 10090 – Community Protection against Fire.

Any section of pipe serving a fire hydrant within a residential, industrial, commercial or business area, must be designed in accordance with **Table 5**. This includes the required minimum fire flow as well as the minimum remaining pressure head

(under fire flow plus peak flow conditions) at any node in the water reticulation system. **Table 5** illustrates the minimum fire flow requirements under peak demand conditions.

Table 5: Fire Flow under Peak Demand Conditions

FLOW CONDITION		MIN PRESSURE IN DISTRIBUTION SYSTEM		MAX PRESSURE (AT ANY POINT)	
Peak Hour Demand - minimum		24		90	
Static (no demand) - Maximum				90	
Fire flow (@ peak demand)		See below			
FIRE RISK CATEGORY	**MINIMUM DESIGN FIRE FLOW (ℓ/S)**	**MINIMUM FLOW PER HYDRANT (ℓ/S)**	**MAX SPACING OF HYDRANTS (m)**	**MIN RESIDUAL PRESSURE (m)**	**DURATION OF FIRE FLOW (Hours)**
A	217.00	33.33	85	15	4
B	150.00	33.33	120	15	4
C	100.00	33.33	200	7	2
D1	31.67	20.00	240	6	2
D2	47.50	20.00	200	6	2
D3	63.33	23.33	200	6	2
D4	95.00	33.33	200	6	2
E	Based on risk assessment				

A fire area should be divided into sub-areas, which falls within one of the following fire-risk categories as shown in **Table 6**.

Table 6: Fire-risk Categories

FIRE-RISK CATEGORY	DESCRIPTION
A	Non-residential buildings and divisions not greater than 5 000 m^2
B	Non-residential buildings and divisions not greater than 2 500 m^2
C	Non-residential premises not greater than 1 250 m^2
D1	Houses > 30 m apart
D2	Houses 10.1 to 30 m apart
D3	Houses 3 to 10 m apart
D4	Houses < 3 m apart
E	As determined by risk assessment

Designers are referred to the following publications:

Outside stands:

- SANS 10090 – Community Protection Against Fire

Within stands:

- National Building Regulations and Building Standards Act, 1977 (Act No 103 of 1977)
- Part W – Fire Installation of SANS 10400 – The Application of the National Building Regulations (latest addition) and,
- On-site Rational Designs by a Competent Person executed in accordance with the above legislation and National Standard.

2.2.5 Position of pipes

2.2.5.1 Depth of pipes below final ground level

The following minimum depths are prescribed:

- Stream and river crossings: 1.2 m *
- Wetlands and vlei crossings: 1.2 m *
- Undeveloped / open areas: 1.0 m
- On sidewalks: 1.0 m
- Road crossings: 1.5 m
- Across erven: 1.0 m. No pipes will be allowed across erven unless very special circumstances justify the deviation from this guideline. Prior approval / authorisation must however be obtained from CoE
- In close proximity of other services: 1.0 m. Services sharing the same trenchis not preferred, but could be considered with prior approval / authorisation from CoE
- Erf connections: 0.5 m

Pipe cover should not exceed 2.0 m unless prior approval / authorisation is obtained from CoE.

* *Special attention must be given to the design of river crossings, where welded steel pipes shall preferably be used.*

2.2.5.2 Horizontal alignment of pipes

All water pressure pipelines shall be installed 1.0 m from erf boundaries for all road reserves.

Where this is not possible, services shall be installed as follows:

- When new services are required to connect into existing reticulation systems in recently developed townships, the placement of the new water services must be placed in accordance with the positions set out in the standard drawings representing the positions of the various services for different road reserve widths and road uses.
- When new services are required to connect into existing reticulation systems in older townships, the placement of the new water services must be placed in accordance with the positions set out in the standard or at the distances prescribed by the Head of Department: Water and Sanitation Department from time to time.

2.2.6 Thrust / anchor blocks

Thrust / anchor blocks must be specifically designed for each fitting according to the soil conditions and the expected maximum pressure (e.g. static / surge) at that point. Valves, bends, tees and end stops / plugs must be adequately anchored.

2.3 Valves

Refer to **Annexure B** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

2.3.1 Isolating valves

- Valves must be placed directly opposite the closest splay corner pegs in networks;
- Line valves must be installed not more than 1 000 m apart on feeder and discharge pipelines in order to isolate sections for maintenance purposes;
- In reticulation systems, isolating valves should be placed so that not more than four valves need to be closed to isolate a section of main, and so that the total length of main included in an isolated section does not exceed a nominal 600 m;
- Where pipes intersect, isolating valves shall generally be installed in the smaller diameter branches;

- Valves shall generally be located opposite erf boundary (splay) pegs. Avoid placing valves underneath kerb lines or driveways;
- Every effort should be made in the design of the reticulation system for inclusion of alternative supply pipes to connect to the system if maintenance has to be carried out on the main supply pipeline;
- Butterfly valves must be used on pipes larger than 450 mm diameter;

2.3.2 Scour valves

Scour valves shall be installed at all low lying areas within the mainline system to allow for scouring purposes, cleaning and emptying of the mainline. Scour valves shall be positioned to ensure a maximum drainage time of 2 hours per section. Scour valves may not be discharged into underground drainage systems and must be discharged only into open surface drains.

It is preferred that fire hydrants be utilized to scour reticulation and network lines. However, scour valves shall be installed at the end of network lines (i.e. dead ends).

Scour valves shall be of the same type and specification as for isolating wedge gate / RSV type valves.

2.3.3 Pressure and Flow Control Valves

PRV's and FCV's shall be installed where the Consultant in collaboration with CoE's Divisional Head: Water and Sanitation Department – Project, Planning and Operations Divisions, deem it necessary.

PRV's and FCV's shall be sized and installed according to the manufacturer's specifications. All PRV's and FCV's shall be installed with a by-pass arrangement with flanged RSV gate valves on both sides of the valve.

2.3.4 Air Valves

Air valves shall be installed where mainline pipe gradients change from positive to negative. Air valves shall also be spaced approximately 1 000 m apart on the mainline system.

2.4 Water meters

2.4.1 Bulk water meters

No connection of secondary reticulation networks to main (bulk) water lines shall be permitted without a bulk water meter approved by the Divisional Head: Water and Sanitation – Revenue Division.

In the case of low cost housing developments, a bulk water meter with associated PRV (if required) shall be installed at the inlet connection point to the development. The bulk water meter as well as the PRV must be appropriately sized. Should there be more than one inlet connection point to the development, both shall be equipped with a bulk water meter and PRV, if required.

At boundaries of private road reserves (to private enclosed developments / restricted access developments) one bulk meter will be installed at the cost of the developer.

A bulk water meter shall be installed in accordance with the latest Meter Specifications as compiled and approved by the Divisional Head: Water and Sanitation – Revenue Division. Bulk water meters shall be sized and installed according to the manufacturer's specifications. All meters should be installed with an NRV.

Bulk water meters shall be installed above ground where possible. Should it be required to install a meter below ground level, a reinforced concrete chamber shall be constructed.

Bulk zone meters shall be installed with a by-pass, including isolating valves on either side of the meter.

NRV's shall be provided with all bulk consumer meter installations. In the case where a combination meter with a NRV function is used, no additional NRV shall be required.

2.4.2 Reticulation water meters

No individual erf water meters shall be installed by the developer.

All water connections are required to end with an SANS-approved isolating valve in accordance with the requirements set out in **Annexure C** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

2.5 Valve markers

Valve marker shall be placed within 500mm from the closest erf boundary.

Valve markers are not required for hydrants since the hydrant standpipe is act as the marker.

Refer to **Annexure B** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

2.6 Valve boxes / chambers

All reticulation isolation valves shall be installed in valve boxes whilst zone valves, air valves, isolating valves on mainline systems, scour valves and control valves shall be installed in reinforced concrete chambers with the relevant designed thrust blocks, puddle flanges (where necessary) and access covers.

2.6.1 Valve boxes

The placement of valves in roadways should be avoided at all times.

Valve boxes must be specified in accordance with **Annexure C** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

2.6.2 Valve chambers

All chambers shall be purposely designed to suite the specific valve installation with regards to size and type. Chambers shall be constructed from reinforced concrete, in accordance with the relevant SANS Specifications pertaining to water retaining structures and sealed to prevent stormwater ingress.

Within the chambers, provision shall be made for sufficient workspace (400 mm minimum all round). Chambers shall also be equipped with a drainage sump in accordance with the standard drawings. All chambers shall have removable reinforced concrete cover slabs, designed for the specific chamber and load conditions with cast in manhole cover and frame according to standard drawing. All chambers shall be protected with a suitable locking mechanism cast into the concrete chamber cover, refer to standard drawings. Provision shall also be made for 100mm Ø holes above all isolating valves in the cover slab.

All valve chambers shall be provided with sufficient air vents for ventilation.

2.7 Property / erf connections

2.7.1 General requirements

For normal residential, industrial and commercial developments, water reticulation shall be installed within the road reserve of public roads in accordance with the specifications set out in this document.

Erf connection pipes must be installed from the water reticulation connection for each erf, up to the isolating ball valve. All erf connections and / or communication pipes shall be fitted with the appropriate compression 'Plasson' fittings (according to **Annexure B** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services". No other fittings shall be accepted unless otherwise approved by the Division Head: Operations Division.

Head of Department: Water and Sanitation in association with the Divisional Head: Water and Sanitation – Planning Division will determine the type of installation required for each area and / or development in accordance with the requirements set out in the CoE standard drawings. All connections must be specified, supplied and installed in accordance with **Annexure C** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

Property connections on pipes larger than 250 mm diameter will only be made in exceptional circumstances with the approval of the Head of Department: Water and Sanitation: Planning Division.

2.7.2 Connection requirements

- All property connections shall be a minimum PE100, PN 16, SDR11 HDPE pipe for a maximum potential static pressure of 1200 kPa;
- Long connections underneath streets must have no joints under the paved roadway or kerbs;
- Strainers and NRV's shall be installed on all metered water connections larger than 25mm diameter.

Table 7: Recommended pipe diameters for house connections

POTENTIAL LAND USE	NOMINAL OUTSIDE DIAMETER (MM)		
	SERVING TWO ERVEN	SERVING ONE ERF FAR SIDE	SERVING ONE ERF NEAR SIDE
Subdivision/second dwellings, up to 4 units	40 mm, branching to 2 x 25 mm	40 mm, reducing to 25 mm at erf	32 mm, reducing to 25 mm at erf
Maximum of one dwelling per erf	32 mm, branching to 2 x 25 mm	32 mm, reducing to 25 mm at erf	25 mm
Low-cost housing	25 mm , branching to 2 x 20 mm	25 mm, reducing to 20 mm at erf	20 mm

Note: Where there is a possibility that network water pressures will in future be reduced in order to minimise water loss, it may be necessary to install communication pipes up to the house that are 40 mm in diameter to have a sufficient flow at the houses

2.7.3 Connections to all multi-residential erven and other land uses

The diameter of connecting pipes must be determined by the potential flow to the planned development with due regard to fire flow requirements. Meter installations larger than 20 mm diameter must be manufactured from SANS and Jaswic approved material, poly carb / HDPE piping, and SANS and Jaswic approved valves in accordance with **Annexure C** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

2.8 Fire hydrants

Hydrants shall be installed 450mm from erf boundaries and spaced in accordance with fire flow requirements.

A blue reflectors / "cat's eye" with a blue backing shall be fixed to the kerb, in line with the hydrant.

2.9 Field testing, inspection and taking over

All erf connections and / or draw off points shall be included in the final testing of the new water network, in accordance with the relevant requirements of SABS 1200. Separate testing of the erf connections and / or draw off points shall not be accepted. The contractor must ensure that the test is achievable and correct prior to calling of CoE officials to witness the test.

The Projects Manager – Department of Water and Sanitation shall inspect the installation and witness the final testing of the new water network. No connections / tie-ins of new pipe(s) to the existing infrastructure shall be allowed unless all tests have been done, approved and accepted. CoE will do the connection to the existing infrastructure in accordance with the approved design. This work will be done at the cost of the applicant who must request the CoE to execute the work. Standard tariffs for different sizes of pipe will be applicable and must be paid by the applicant before any work will be done by CoE.

Upon acceptance of the final testing, the ownership and maintenance of the network will be taken over by the Department of Water and Sanitation – Operations Division. However, CoE will only take over the operational and maintenance responsibility of infrastructure from a developer (including connections) upon proclamation and / or registration of subdivisions, where applicable.

In the case of a "security" residential development, where access to the individual properties will be controlled by means of a "private road", the internal water reticulation is installed on private property and shall therefore remain the property and responsibility of the registered owner of the development. In this case, only a metered connection point will be provided by the Department Water and Sanitation – Revenue Division at the boundary of the "private road".

2.10 Dolomite

It is of the utmost importance that no leakage emanating from water infrastructure occurs in dolomite areas.

The requirements of the following national standard shall be implemented for all water infrastructure in areas underlain by dolomite:

- SANS 1936:2012 – "Development of Dolomite Land", Parts 1 to 4 and in particular Part 3: "Design and Construction of Buildings, Structures and Infrastructure"

Consultants may also consult the following publications for further information:

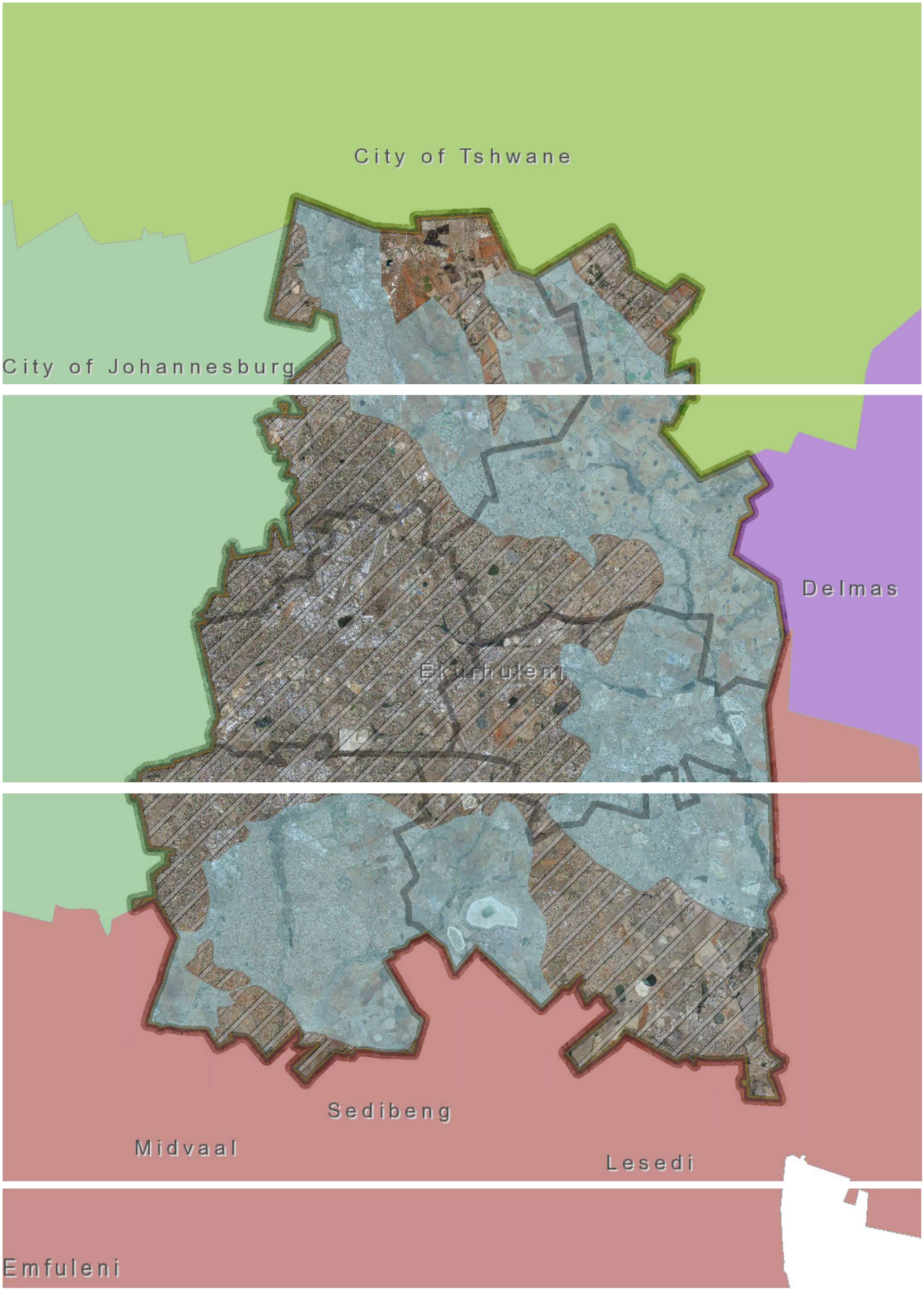
- "Proposed method for dolomite land hazard and risk assessment in South Africa", SAICE Journal Volume 43(2) 2001, paper 462 pages 27-36, Buttrick et. al. (current industry standard document)
- Section 2.8 of Part 1 of the Home Building Manual as published by the NHBRC, Revision 1, 1999
- PW344: "Appropriate Development Infrastructure on Dolomite: Manual for Consultants" as published by the National Department of Public Works, June 2006. This document is available under Consultants Documents on the website of the Department of Public Works (www.publicworks.gov.za)

Consultants shall obtain the Dolomite Report for the specific development before the design of the water network commences. The map included in below depicts, in broad terms, the areas within the CoE which are known to be underlain by dolomites.

Alternative routing of wet services around high-risk areas should always be investigated.

The minimum standards for water services in areas underlain by dolomite are as follows:

- Underground wet services shall be designed and constructed to minimise maintenance requirements and to avoid potential leakage points. In addition, liquids shall be contained in watertight structures to avoid possible disturbance of the underground environment.
- The relevant portions of the Standard Specifications for Municipal Civil Engineering Works shall be applied in the installation of all underground services.
- The backfilling to service trenches and other excavations shall, except in rock, be less permeable than the surrounding material. General minimum compaction standard to be 93% Mod AASHTO, provided permeability requirements are met. The use of non-cohesive single size graded sand or crusher sand for bedding, surround blankets and backfill shall not be allowed.
- Where feasible, provision for future connections to all services should be made in order to minimize cutting into pipes to provide such connections at a later stage.
- Provision should be made in all pipelines transporting water to accommodate potential differential movements without causing pipelines or joints to leak.
- Valves shall be flanged resilient seal gate valves and be fitted to butt welded flanges only.


City of Tshwane
City of Johannesburg
Delmas
Ekurhuleni
Sedibeng
Midvaal
Lesedi
Emfuleni

3 SANITATION RETICULATION

3.1 General requirements

This Section covers the planning and design of sewer reticulation and sewer mains / links (bulk sewer).

Sewer reticulation for residential, industrial and commercial development shall be implemented in accordance with the guidelines and standards in this document document within the road reserve of a public road or within a servitude registered for this purpose in the name of CoE..

All work (pipes, manholes etc.) must comply with CoE standards and drawings as per Annexure C of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

Upon completion, the sewer reticulation shall be inspected by the relevant Water and Sanitation – Division. Once approved, and the required documentation as specified in paragraph 1.4 are submitted, the ownership and maintenance of the infrastructure will be taken over by Water and Sanitation – Operations Division. In case of a private development, CoE will only take-over the operations and maintenance responsibility of infrastructure from the developer (including connections) upon proclamation and / or registration of a subdivision, where applicable.

Where Municipal sewers cross private properties and the sewers are not protected by servitudes in terms of the conditions of establishment / township, the registration of servitudes in favour of the CoE will be required, at the cost of the Applicant.

The design of sewer reticulation systems shall ensure sufficient capacity for the type of development proposed. The proposed system shall be designed to integrate with existing and future developments and provide a sewer connection at the street front of every erf.

The design of each development's sewer reticulation system has to be submitted to the CoE for incorporation into their overall sewer system. A hydraulic modelling analysis must be submitted for each development in order to evaluate and properly develop existing sewer systems.

The works shall comply with SANS 1200 unless otherwise specified in this Guideline document or per specific conditions of the tender document.

A detailed site investigation must be undertaken to establish the location of all existing infrastructure and affected services to faciliate the design of the sewer system. Plans and records of these services must be obtained from the relevant service providers and approval must be obtained when their services are affected. A layout plan indicating the location of all existing services in relation to the planned location of new services must be submitted to the relevant CoE division for approval.

A gravity sewer reticulation shall be installed for all types of developments, in accordance with the specifications of this Guideline Document. The sewer reticulation system shall be placed either within the road reserve of a public road or within the necessary servitude on private property. Upon completion, the sewer reticulation shall be inspected by CoE's Water and Sanitation Department where after the ownership will be transferred to CoE's Operations Division, who will be responsible for the operation and maintenance of the network.

The CoE will only consider municipal sewer pump stations in exceptional circumstances, after all other alternatives have been exhausted. It must be avoided as far as possible and will only considered if gravity transfer of sewage is not possible and / or feasible with the approval of the HOD: Water and Sanitation Department.

New private developments shall not make use of septic tanks, conservancy tanks, "French drains" or any other sewer system, unless approved by CoE's Divisional Head: Planning Division.

3.2 Design guidelines

3.2.1 Unit demands for master planning

During the planning stages of a development, formalised site layout plans or specific land uses might not be readily available. For long-term planning, the ultimate development potential must be taken into consideration (i.e. densification increases) on a continuous basis. The design of outfall sewers must cater for all potential development scenarios upstream to allow for proper implementation of wastewater treatment facilities and other related bulk sewer infrastructure i.e. pump stations. Use of **Table 8** to calculate average dry weather flow (ADWF) must therefore be made for long-term water master planning purposes or until layout plans or specific land uses have been finalised.

Table 8: Summarised Planning Standards for ADWF

LAND USE	TYPICAL DENSITY (erven / ha)	GUIDELINE DISCHARGE (kℓ / ha / day)
Residential I	10	10.00
Residential I and II	20	16.00
Residential III	40	22.00
Residential IV	60	27.50
Residential IV	80	32.00
Residential IV	100	40.00
Residential IV	120	48.00
Agricultural Holding	1	1.40
Business/Commercial	0.4 FAR [1]	30.00
Industrial	0.6 FAR [1]	22.00

[1]FAR – Floor Area Ratio

3.2.2 Unit demands for detail engineering design

As a general guide for determining sewer discharge, it can be assumed that the discharge will be approximately 80% of the daily water consumption for fully developed areas. Use of **Table 9** must be made to calculate ADWF during detail design, when layout plans or specific land uses have been finalised.

Table 9: Design Standards for Average Dry Weather Flow (ADWF)

ITEM	ZONING	UNIT/DAY	ADWF (kℓ/day)
1	**RESIDENTIAL**		
1.1	Low-cost housing – erf up to 500 m²	kℓ per erf	0.6
1.2	Conventional small sized erf up to 500m²	kℓ per erf	0.5
1.3	Medium sized erf 501m² - 1000m²	kℓ per erf	0.5
1.4	Large-sized erf 1 001 m² up to 1 500 m²	kℓ per erf	0.6
1.5	Extra-large erf 1 501 m² and larger	kℓ per erf	1.0
1.6	Cluster housing up to 20 units per hectare (Res 2)	kℓ per unit	0.65
1.7	Cluster housing 21 up to 40 units per hectare (Res 3)	kℓ per unit	0.53
1.8	Cluster housing 41 up to 60 units per hectare (Res 4)	kℓ per unit	0.4
1.9	Cluster housing 61 up to 80 units per hectare (Res 4)	kℓ per unit	0.34
1.10	Cluster housing 81 up to 100 units per hectare (Res 4)	kℓ per unit	0.28
1.11	High-rise flats (± 50 m² per unit) according to FSR	kℓ per 100 m²	0.4
1.12	Boarding houses, hostels, hotels, retirement centers & villages, orphanages	kℓ per 100m²	0.6

ITEM	ZONING	UNIT/DAY	ADWF (kℓ/day)
1.13	Guesthouses - allocation per room regardless of room size	kℓ per room	0.4
1.14	Agricultural holdings & farm land (connection for domestic use only)	kℓ per domestic unit	1.56
1.15	Agricultural holdings (house + servants quarters + garden) (to be used only for subdivisions to create multiple holdings)	kℓ per holding	1.4
1.16	Gate house for security villages	kℓ per unit	0.2
2	**BUSINESS DEVELOPMENTS**		
2.1	General business with an FAR (dry)	kℓ per 100m²	0.6
2.2	General business with an FAR (wet)	kℓ per 100m²	0.8
2.3	Business and offices	kℓ per 100m²	0.44
2.4	Gym, health spa	kℓ per 100m²	0.4
2.5	Commercial	kℓ per 100m²	0.7
2.6	Restaurant, bakery	kℓ per wash bay	0.8
2.7	Butchery	kℓ per 100m²	0.2
2.8	Warehousing (including up to 20% offices)	kℓ per 100m²	0.4
2.9	Garage or filling station	kℓ per 100m²	1.0
2.10	Car wash facility (no recycling)	kℓ per wash bay	6.0
2.11	Car wash facility (with recycling plant)	kℓ per wash bay	3.6
2.12	Motor city / Retail park as a single zoning (car sales + limited offices)	kℓ per 100m²	0.4
2.13	Vehicle parking garage/grounds	kℓ per bay	0.0
2.14	Nursery (sales area)	kℓ per 100m²	0.4
2.15	Nursery (planting and production area)	kℓ per hectare	0.2
3	**INDUSTRIAL DEVELOPMENT**		
3.1	Industrial (dry)	kl per 100m²	0.4
3.2	Industrial (wet)	kl per 100m²	min of 1.0 kl
4	**INSTITUTIONAL USES**		
4.1	Club buildings	kl per 100m²	0.3
4.2	Club grounds	kl per hectare	0.0
4.3	Stadium building	per 1 000 people	1.5
4.4	Stadium grounds	kl per hectare	0.0
4.5	Municipal park buildings	kl per 100m²	0.4
4.6	Municipal park grounds	kl per hectare	0.0
4.7	Hospital buildings without laundry	kl per 100m²	1.0
4.8	Hospital buildings with laundry	kl per 100m²	3.15
4.9	Hospital grounds	kl per hectare	0.0
4.10	Church buildings	kl per 100m²	0.1
4.11	Church grounds	kl per hectare	1.0
4.12	School, crèche, educational buildings	kl per pupil	0.5
4.13	School, crèche, educational grounds	kl per hectare	0.5
4.14	Municipal, governmental developments	kl per 100m²	0.8
5	**MISCELLANEOUS USES**		
5.1	Mixed use	kl per hectare	13.0
5.2	Private open space	kl per hectare	0.0
5.3	Special	Development specific	Development specific
5.4	Home enterprise (dry, office, IT)	kl per 100 m²	0.4
5.5	Home enterprise (wet, tavern, hairdresser)	kl per 100 m²	0.8

[1] FAR – Floor Area Ratio

Calculations to be based on the potential area or number of units being applied for.

3.2.3 Hydraulic design

3.2.3.1 Design flow and pipe capacity

- Network / reticulation sewer lines shall have a full flow depth of 50% (d/D) at design flow, including allowance for infiltration (15% of ADWF).
- Outfall sewers shall have a full flow depth of 70% (d/D) at design flow, including allowance for infiltration (15% of ADWF).

Providing a full flow capacity of at least 80% at peak dry weather flow (PDWF) with the remaining 20% allocated for extraneous flows (storm water ingress) as shown in **Figure 1**. The peak flow must be calculated with a peak factor of **2.5** irrispective of the number of erven.

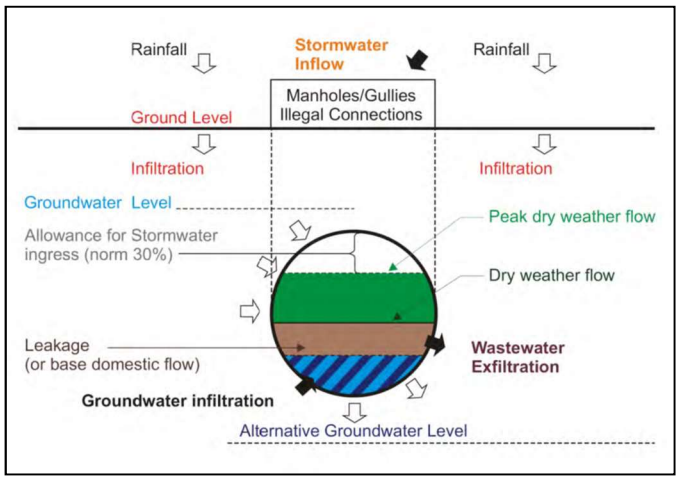


Figure 1: Concept of extraneous flows in a waterborne sewer (CTMM, 2009)

Peak discharge: Peak factor (PF) x ADWF

The minimum allowable internal diameter for any municipal sewer pipe is 145 mm (160 mm OD).

Table 10: Sewer flow friction formulae

FORMULAE	PARAMETER AND UNITS
Manning $Q = \mathrm{A}\frac{R^{\frac{2}{3}}\sqrt{S}}{\mathrm{n}}$	Q = flow rate (m^3/s) n = coefficient of roughness ($s/m^{1/3}$) A = flow area (m^2) P = wetted perimeter (m) R = hydraulic radius (m) – A/P S = slope of the energy grade line (m/m)

The following typical Manning values should be used:

- New / finished concrete pipes: 0.012
- Old / unfinished concrete pipes: 0.015
- Vitrified sewer pipes: 0.014
- Corrugated Polyethylene (PE) with smooth inner walls: 0.012

- Polyvinyl Chloride (PVC) with smooth inner walls 0.010

3.2.3.2 Pipe flow velocity

Pipe flow velocity should fall within the limits specified in **Table 11**

Table 11: Sewer flow velocities

TYPE OF PIPE	MINIMUM FULL FLOW VELOCIT (m/s)
Gravity mains	0.70
Rising mains	0.70

3.2.3.3 Pipe gradient

Where possible, sewer lines should follow the natural slope of the ground provided that the minimum flow velocity of 0.7 m/s is maintained with sufficient hydraulic capacity. The minimum gradients, as specified in **Table 12** shall be adhered to.

Table 12: Minimum gradients

NUMBER OF DWELLINGS	MINIMUM GRADIENT
< 10	1:80
10 - 30	1:100
> 30	1:150
PIPE DIAMETER	**MINIMUM GRADIENT**
110 mm diameter (house connections)	1:60
160 mm diameter	1:150
200 mm diameter	1:200
250 mm diameter	1:250
315 mm diameter	1:300
355 mm diameter	1: 350
400 mm diameter	1 : 400
450 mm diameter	1 : 450
500 mm diameter	1 : 500
> 500 mm diameter	Slope must ensure minimum full flow velocity of 0.70 m/s is maintained

Special approval is required from CoE for gradients larger than 1: 500.

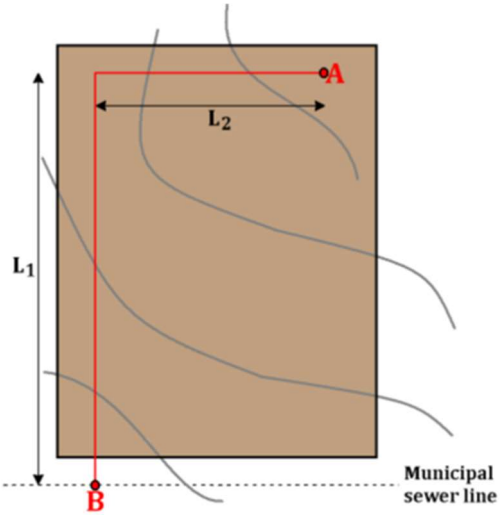
3.2.3.4 Depths of sewer pipes below natural ground level

A sewer connection must be provided to drain the total developable area of the erf. The sewer invert level at each erf connection must be designed so that the most critical point in the erf can drain to the sewer at a minimum gradient of 1:60. The erf connection must have a minimum cover of 300 mm at any point in the erf.

A minimum allowance of 100 mm must be made for survey (DTM) error. An allowance for the actual DTM error shall be made if the mean square error is larger than 100 mm.

The minimum depth to invert level of the erf / house connection = cover + DTM error + pipe diameter = 500 mm.

Provided that the natural ground slope along the house connection is less than 1:60 the sewer invert level at each house connection can be calculated as follows:



D_B = Depth of invert of house connection at point B

$D_B = (L_1 + L_2) / 60 + 0.5 - (Z_A - Z_B)$

L_1 and L_2 = Maximum length of private sewer as shown

Z_A = Ground level at point A

Z_B = Ground level at point B (normally the lowest point of the erf adjacent to municipal sewer)

The following must be considered:

- The invert level of the erf connection must be connected to the soffit of the municipal sewer.
- The invert level of the sewer line at the house connection B may therefore not be less than:
  Invert level = $ZA – 0.5 - (L_1 + L_2) / 60$

The following minimum depths are prescribed:

- Stream and river crossings: 1.2 m *

- Reticulation pipes ouside road reserves: 1.0 m.
- Reticulation pipes inside road reserves: 1.4 m.
- Reticulation pipes and erf connections with cover of less than 0.8 m under road surface shall be encased in soilcrete.

The minimum depths stipulated above can be decreased where the depth of the existing infrastructure dictates otherwise (depending on the invert level of the existing sewer). Exceptional cases will be considered on their merits after consultation with the Divisional Head: Operations Division.

3.2.3.5 Steep slopes

For gradients steeper than 1:10, concrete anchor blocks should be provided at pipe joints.

Sewer at a slope of 1 in 6 or steeper must be encased in 15 MPa concrete with a minimum thickness of 150 mm around the barrel of the pipe. The consultant to determine detail of anchoring, but the anchor blocks may not be spaced more than 12 m apart.

3.2.3.6 Road crossings

Sewer crossing under surfaced roads (existing tar roads) may not be encased in concrete as a rule. However, an engineering design must be submitted, indicating the protection measures (which must be approved by the Divisional Head: Projects Division) for any sewer road crossing shallower than 1.5 m.

The trench must be backfilled in accordance with the specifications of the CoE: Roads and Storm Water Department. The selected materials must be compacted to a depth of at least 300 mm above the top of the pipe by means of compactors to ensure the specified compaction density.

3.2.4 Routing/location

For routing of sewer lines, the following aspects should be considered:

- The sewer line must follow the natural fall of the ground.
- The sewer line must be installed in and/or adjacent to the properties that will benefit most from the line.
- Road crossings must be kept to a minimum.
- The sewer must have minimum interference with existing infrastructure and other services.
- All sewer reticulation pipes shall be installed according to the standard services layout drawings.
- Sewers installed within the road reserve boundary must be positioned in accordance standard drawing indicating the positions of the various services. (See also specific positions in areas underlain by dolomite.)
- Where the sewer and water lines are to be installed in the same trench, sewer manholes must be positioned so as to allow for a minimum clear distance of 500 mm between the outside of any manhole and the water pipeline.
- The final finished levels of carriageways, sidewalks and vehicle entrances to properties, and the depth of sewer inverts below finished sidewalk levels, particularly for steep cross-falls, must be considered in the design of sewers.
- All other services must be taken into account.

3.2.5 Sewer pumping lines (rising mains)

The pumping of sewage must be avoided as far as possible and only considered if gravity transfer of sewage is not possible and / or feasible. Accordingly, the installation of sewer pumping lines is strictly dependent on approval of CoE's HOD – Water and Sanitation Department.

The design of sewer pumping lines shall comply with the following minimum standards:

- The minimum diameter of a rising main shall be 160 mm.
- The minimum velocity shall be 0.7 m/s with a maximum velocity not exceeding 1.5 m/s.
- The vertical alignment of the rising main must be such that air and scour valves are avoided or kept to an absolute minimum where it is required due to site conditions.
- Air pockets must be avoided by using a gradient greater than 0.3% (1:333) for small diameters and 0.2% (1:500) for large diameter pipelines.
- Stilling chambers must be provided at heads of all rising mains with sufficient ventilation. The stilling chamber must be designed so that the water level is above the soffit of the pipeline entering the chamber.

3.2.6 Sewer system in mid-blocks

Mid-block systems are not permitted and will only be allowed under special conditions with the approval of CoE's Divisional Head: Water and Sanitation Department – Project, Planning and Operations Divisions.

3.3 Sewer junctions (junction, cleaning eyes, lampholes and manholes)

3.3.1 Junction of sewers

The junction with an interceptor sewer must generally be soffit (top of pipe) to soffit; with due design consideration to the hydraulic energy lines through the junction.

3.3.2 Cleaning eyes & lampholes

Cleaning eyes and lamp holes in road reserves and erven, may only be placed at the higher end of sections shorter than 15 m, serving a maximum of two dwelling units.

3.3.3 Manholes

3.3.3.1 Manhole placement

Manholes must be placed as follows:

- At intervals of 80 m on network sewers. A larger spacing may be accepted for outfall sewers of diameters greater than 600mm, subject to approval by CoE of each proposed installation. On collector sewers, and especially outfall sewers, the distance between manholes may be increased in consultation with the CoE. The manhole spacing should be reduced where steep grades are encountered to limit the head on any part of the sewer to **6 m** maximum under blockage conditions.
- At positions on steep grades (1:10 or steeper), to prevent backpressure in house gullies under blockage conditions.
- At changes in grade and direction.
- Where two or more sewer lines connect.
- At the higher end of all sections that serve more than three dwelling units and that are longer than 50 m.
- At least one manhole must be positioned in the road reserve where a sewer line crosses a road.
- With the establishment of all reticulation systems, a starting manhole shall be introduced.
- Backdrops / drop-manholes will not be considered. Where flows and economy considerations (i.e. trench depth) become significant, the alternative of two closely spaced manholes is the prescribed option.

3.3.3.2 Fall through manholes

Compensation for energy losses must be made by allowing a fall in channels through manholes.

A minimum fall of 75 mm is required for pipes diameters ranging between 160 to 315 mm, up to gradients of 1:15. Where gradients exceed 1:15, the actual fall on the inlet or outlet pipe, whichever is the greatest, plus an additional 25 mm must be provided. For pipe diameters exceeding 315 mm, the actual fall must be calculated from the standard energy equations, as follows:

- Standard Energy Equation:
  $H_1 + V_1^2/2g = H_2 + V_2^2/2g + h$

h = fall in manhole due to gradient
= minimum fall
= S x (diameter of manhole)
= energy loss through manhole
S = gradient
H = design flow depth on either side of a manhole
V = design velocity on either side of a manhole

- Energy loss due to change in direction:
  $h_b = K_b (Vf^2/2g)$
  h_b = Energy loss in metres due to bend
  K_b = Loss coefficient, which is a function of the change in direction (refer to **Error! Reference source not found.**)
  V_f = Flow velocity with pipe flowing full

Table 13: Loss Coefficients for change in direction

Change in Direction	K_b
0˚ - 22.5 ˚	0.0 - 0.1
22.5˚ - 45 ˚	0.1 - 0.2
45˚ - 90 ˚	- 0.4

3.4 Property / erf connections

3.4.1 General requirements

Each erf in a new township must be serviced by a separate house connection from the main sewer. Traversing neighbouring properties with a private sewer will not be allowed. Cleaning / rodding eyes shall be installed at each house connection to the municipal system.

Erven zoned for use other than special residential, as well as residential erven zoned to a density higher than Residential 1 and with three or more units, must connect to the municipal sewer system with a 160 mm diameter connection out of a manhole. This manhole and connection must be provided on the main sewer during construction of the network of the township.

The sewers for new developments must be implemented in such a way that future developments can easily connect and to minimise the need for additional manholes and sewers. This will require the sewer to be extended to the boundary of the higher lying properties at suitable drainage positions for future developments.

A concrete marker with wire attached to the end cap shall be provided at the terminal point(s).

No private connection(s) shall be allowed after the sewer reticulation has been transferred to CoE's Operations Division. Thereafter, CoE's Water Services shall construct additional connection point(s) against the applicable promulgated tariff.

3.4.2 Connection requirements

- All erf connections shall be 110 mm diameter uPVC.
- For larger users (i.e. cluster developments, business, commercial or industrial), erf connections shall be 160 mm diameter uPVC.

- All erf connections shall be terminated at the road reserve boundary and 1.0 m from the lateral boundaries at the erf / stand's lowest hydraulic point. All erf connections shall be provided with suitable end caps.
- A sewer connection must be provided at the lowest point of each erf, as follows:
  - **For Residential 1 erven:** 110mm diameter house connection from the main sewer to a distance of 500 mm inside the erf boundary and not less than 1.0 m from the side boundary at the lowest point of the boundary.
  - **For a property with a house plus a second dwelling unit:** 110 mm diameter private connection from the main sewer via a private cleaning eye (square cover).
  - **For more than two delling units on any erf up to a maximum of three units:** 160 mm diameter sewer connection to the main sewer via a lamp hole or cleaning eye.
  - **For more than three units on any erf:** 150 mm diameter sewer connection to the main sewer via a manhole.
  - **For erven zoned for any use other than Residential 1 (Special Residential):** 160mm diameter connection to the main sewer via a manhole.
- The position of each erf connection must be identified with a marker block at ground level. The marker block will be attached to a vertical wire from immediately above the connection but not tied or attached to the connection.

3.5 Existing services

3.5.1 General

The position of all existing and planned public and engineering services must be obtained and ascertained on site. Applicants, consultants and developers must adhere to the conditions set out in the wayleaves from affected service providers.

The conditions of establishment in respect of the building line restrictions, servitudes and other relevant clauses must be taken into account.

3.5.2 Storm water drains

Crossings of storm water drains / drainage should be kept to a minimum. With proper arrangement of manholes, it may be possible for the sewer line to pass underneath storm water drain with minimum additional excavation.

3.5.3 Electrical and telecommunication cables

Prior to installing any sewer, the position of electrical and telecommunication cables must be verified with the relevant authority and all relevant service providers as part of the wayleave application process (Eskom, Telkom, etc.).

3.5.4 Water mains

The exact location of water mains must be verified on site by utilising the position of valve boxes and through exposure of the water mains and house connections where the sewer will be installed.

3.5.5 Trees

No interference or removal of trees on sidewalks will be allowed. Should site circumstances require removal of trees, official approval must be obtained from CoE and Metro Parks.

3.6 Turbulence and odour prevention

Turbulence at junctions and in manholes may cause bad odours which must be limited by the following:

- By ensuring that sewer connections to interceptor sewers is kept to an absolute minimum
- By avoiding areas that may lead to hydraulic jumps (i.e. ramps, sudden changes in gradients from steep to flat – rapid change in slope i.e. where the upstream grade is more than five times the downstream grade of the sewer)
- By avoiding steep drops in manholes, and
- By adequately and correctly shaping channels and benching in manhole

3.7 Field testing, inspection and taking over

All erf connections shall be included in the final testing of the new sewer network, in accordance with the relevant requirements of SABS 1200. Separate testing of the erf connections shall not be accepted. The contractor must ensure that the test is achievable and correct prior to calling of CoE officials to witness the test.

The Projects Manager – Department of Water and Sanitation shall inspect the installation and witness the final testing of the new sewer reticulation. No connections / tie-ins of new pipe(s) to the existing infrastructure shall be allowed unless all tests have been done, approved and accepted. CoE will do the connection to the existing infrastructure in accordance with the approved design. This work will be done at the cost of the applicant who must request the CoE to execute the work. Standard tariffs for different sizes of pipe will be applicable and must be paid by the applicant before any work will be done by CoE.

The results of CCTV inspection(s), including the inspection the gradient of the newly laid pipes, shall be submitted to CoE. Upon acceptance of the final testing and results of the CCTV inspection(s), the ownership and maintenance of the reticulation network will be taken over by the Department of Water and Sanitation – Operations Division. However, CoE will only take over the operational and maintenance responsibility of infrastructure from a developer (including connections) upon proclamation and / or registration of subdivisions, where applicable.

3.8 Dolomite

It is of the utmost importance that no leakage emanating from water infrastructure occurs in dolomite areas.

The requirements of the following national standard shall be implemented for all sewage infrastructure in areas underlain by dolomite:

- SANS 1936:2012 – "Development of Dolomite Land", Parts 1 to 4 and in particular Part 3: "Design and Construction of Buildings, Structures and Infrastructure"

Consultants may also consult the following publications for further information:

- "Proposed method for dolomite land hazard and risk assessment in South Africa", SAICE Journal Volume 43(2) 2001, paper 462 pages 27-36, Buttrick et. al. (current industry standard document)
- Section 2.8 of Part 1 of the Home Building Manual as published by the NHBRC, Revision 1, 1999
- PW344: "Appropriate Development Infrastructure on Dolomite: Manual for Consultants" as published by the National Department of Public Works, June 2006. This document is available under Consultants Documents on the website of the Department of Public Works (www.publicworks.gov.za).

Consultants shall obtain the dolomite report for the specific development before the design of the sewer network commences.

The map in Section 2 (page 14) depicts, in broad terms, the areas within the municipality which are known to be underlain by dolomites.

Alternative routing of wet services around high-risk areas should always be investigated.

The minimum standards for sewer services in areas underlain by Dolomite are as follows:.

Underground wet services shall be designed and constructed to minimise maintenance requirements and to avoid potential leakage points. In addition, liquids shall be contained in watertight structures to avoid possible disturbance of the underground environment.

- The relevant portions of the Standard Specifications for Municipal Civil Engineering Works shall be applied in the installation of all underground services.
- The backfilling to service trenches and other excavations shall, except in rock, be less permeable than the surrounding material. General minimum compaction standard to be 93% Mod AASHTO, provided permeability requirements are met. The use of non-cohesive single size graded sand or crusher sand for bedding, surround blankets and backfill shall not be allowed.
- Where feasible, provision for future connections to all services should be made in order to minimize cutting into pipes to provide such connections at a later stage.
- Provision should be made in all pipelines transporting sewer to accommodate potential differential movements without causing pipelines or joints to leak.
- Valves shall be flanged resilient seal gate valves and be fitted to butt welded flanges only.

4 RESERVOIR GUIDELINES

4.1 General requirements

Regardless of the shape and size of the reservoir, the aesthetics of the reservoir and site should blend in with the natural surroundings.

Above ground reservoirs are preferred as leaks can be easily identified around walls and between wall and floor joints. Shallower underflow drains of above ground reservoirs will further assist in leak detection while easing the cleaning operations of underdrain sumps.

The reservoir must be equipped with the following:

- Inlet pipes;
- Outlet pipe;
- Scour chamber / pipe with a valve;
- Standard access manholes with a watertight, lockable cover raised 200mm above the roof top surface;
- Overflow pipe with the necessary discharge arrangements;
- Air vents – these should not give access to insects, birds or other contaminants;
- Access ladders mounted both inside and outside the reservoir;
- A 2.0 m wide concrete apron around the reservoir and a 1.0 m wide storm water v-drain; and
- A network of under floor drains (to collect any leakage and/or if the ground water table rises);
- All pipes running below the reservoir will be encased in mass concrete.

4.2 Design Codes and Standards

The design of reservoirs structure and pipe works infrastructure within the CoE must comply with the following designed requirements, amongst others, according to the latest edition of the following Codes, Standards and Statutory Regulations: The SABS / SANS.

- SANS 10100: The structural use of concrete,
- SABS 0162-1: The structural use of steel;
- SANS 10160- Series -: The general procedures and loading to be adopted in the design of buildings;
- SANS 1200: Standardized Specification for Civil Engineering Construction; and
- BS 8007: 1978 – British Standard Code of Practice for Design of Concrete Structure for Retaining Aqueous Liquids.

4.3 Reservoir sizing

Sufficient storage must be provided to meet balancing requirements and to cater for emergency and / or planned shutdowns of the supply to the distribution system by CoE or Rand Water. The sizing should also align with the RW Application.

Table 14: Reservoir Storage requirements

Reservoir Storage	Capacity	Additional capacity for Fire Flow
Supply under gravity	36 Hours of AADD	Equal to fire flow requirements (refer to Section 2.2.4)
Supply under pumping	36 Hours of AADD	

4.4 Supply rates

Flow control valves should regulate the flow to reservoirs.

The recommended flow rate to the reservoir is 1.5 times the AADD. The flow control valve should have an ultimate capacity to comply with the required inflows under the ultimate AADD for the reservoir zone.

A recommended peak demand supply factor of 3.0 must applied to the AADD from the reservoir. The outlet pipework must be designed using a required peak flow.

4.5 Structural design

4.5.1 General

All reservoirs should be concrete, with no painting of the external structure to facilitate ease of maintenance.

A pre-stressed concrete reservoir wall with a uniform thickness constructed monolithically with the wall foundation is recommended. The prestressing cables must be anchored at buttresses equally spaced around the perimeter of the reservoir wall. Cables must be arranged so as to minimize the effect of losses due to friction and to produce a constant prestressing force around the tank perimeter.

Flat roof reservoirs are preferred as maintenance of domed roof reservoirs remain a challenge. A conventionally reinforced concrete roof slab with the top surface sloping from the centre towards the perimeter to facilitate drainage of rain water is recommended. The roof must be covered with a 100 mm thick layer of 19 mm diameter crushed stone to provide thermal insulation. Column foundations are to be constructed off the floor slab so as to eliminate penetrations through the floor. An upstand beam around the edge of the roof must be provided to:

- retain the crashed stone insulating layer; and
- control and guide roof run-off, which must be discharged through weep-holes strategically positioned.

The floor must be provided with underfloor drains positioned immediately below the expansion/contraction joints in the floor. In addition, a 100 mm thick no-fines concrete drainage layer must be provided under the complete floor area. The floor drains discharge to a perimeter drain with inspection eyes at each junction to facilitate the detection of any leaks at the floor joints.

4.5.2 Recommended loadings

- Roof – 100 mm thick layer of 19 mm saturated crushed stone on roof slab (Live load of 2.5 kPa);
- Wall – Hydrostatic pressure due to water (10 kN/m³ density);
- Minimum cover to all reinforcement of 40 mm;
- Maximum design crack width of 0.1 mm.

4.5.3 Materials

- Concrete – Class 35/19 as minimum with minimum cement content of 420 kg/m³;
- SANS 1200: Standardized Specification for Civil Engineering Construction;
- Reinforcing Steel – 450 MPa yield strength; and
- Structural Steel – Grade 355W for hot rolled sections and Grade 355W for plates.

4.5.4 Pipework inside reservoir

All pipework cast-in concrete and inside the reservoir shall be stainless steel grade 316L, lined and coated with epoxy. All other pipework will be in accordance with the requirements of **Annexure B** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

Flexible joints (i.e. couplings, Victaulic clamps or flange adaptors) are not allowed inside reservoirs.

4.5.5 Ventilation, access opening and ladders

The design shall make provision safe access into the reservoir and adequate ventilation into the reservoir. The ladder inside the reservoir shall be stainless steel grade 316L.

Ventilators shall be designed to allow sufficient air inlet but prevent entry of dirt, birds, insects and other objects that can affect the quality of water inside the reservoir.

4.5.6 Sealing of reservoirs

Special measures shall be implemented to prevent reservoir leaks. The consultant shall submit the design and specification in this regard for CoE's review.

4.6 Pipework and valves

This section should be read in conjunction with **Annexure B** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

4.6.1 Inlet, outlet, overflow and scour pipework

- All pipework must be sized to have an acceptable flow velocity of between 1.0 m/s to 1.5 m/s;
- A water meter must be installed where the main supply pipeline enters the reservoirs site. This is to enable CoE to do a water balance and identify possible leaks on the supply line;
- After the water meter, a chamber with FCV / ACV combination must be constructed to control / limit the flow to the designed AADD. This will also ensure valve closure when the reservoir reaches its full supply level. The system must be a duplicate to allow maintenance of the control valves without disrupting the operation of the reservoir;
- An isolating valve is required on each inlet to allow selective operation of the inlets if required;
- The inlet and outlet pipes shall be positioned to ensure good circulation of the water and prevent stagnant areas.
- Two bottom outlets must be provided that will combine into a single pipe outside the reservoir. The combined outlet must be metered and the outlet pipe must be constructed to the reservoir site boundary wall. Isolating valves must be installed on each individual outlet to allow selective operation if required;
- An overflow pipe must be installed which will enter an inspection chamber;
- The overflow capacity shall be adequate to accommodate any possible inflow scenario in future, during periods where there will be no water flowing from the reservoir through the outlet and the level control is not working.
- A scour pipe must be installed with an isolation valve and the scour pipe to be linked to the overflow inspection chamber;

- The design shall provide for a channel system to transport the overflow water away from the reservoir site, without causing erosion, taking health and safety into consideration and to an area where it can do no harm to the public and environment. The consultant shall obtain CoE's approval for the proposed design.
- A scour pipe must convey water from the reservoir to the nearest existing storm water system; and
- The scouring capacity shall be adequate to empty a full reservoir in 36 hours. The same requirements applicable to channel overflow water away from the reservoir site also apply to scouring.
- Minimum scour velocity of 0.6 m/s to be achieved in main pipeline.
- A manual by-pass system must be included, should the need arise to completely isolate the reservoir from the supply and distribution networks.

4.6.2 Valves

4.6.2.1 Level control

Hydraulic level control valves are preferred to valves with actuators as they do not require any electricity, require minimal maintenance and lower operating costs.

The following three types of hydraulic level control valves will be considered:

- Altitude level control: Can be used where the reservoir is supplied by a dedicated inflow with no off-takes on the supply pipeline.
- Flow rate control: Can be used where off-takes are present on the supply pipeline. The flow rate can be controlled with an orifice plate, sized for maximum flow into the reservoir, downstream of the level control valve.
- Float level control valve.

The altitude level -, flow rate - and float level control valves for reservoir inlets shall have a float control pilot and have a pressure rating of Class 16 – flanges shall conform to SABS 1123 table 1 600 / 3.

The valve must be able to function as a two position control valve, either fully open or fully closed. The valve must also allow normal forward flow to fill the reservoir to the maximum level and then close drip-tight at the set-point. It must open to refill the reservoir once the level drops below a fixed level (normally 2 m below the TWL). This delayed opening feature ensures that the valve does not immediately open and subsequently close on a lowering reservoir TWL.

The altitude pilot system shall fully exhaust to atmosphere ensuring the valve opens fully, no modulating control shall be accepted. The pilot control shall be supplied complete with an adjustment range of between 2 m and 14 m.

Valves shall be hydraulically operated globe valves. The inner valve assembly shall be top and bottom guided by means of bearing bushings. The inner valve assembly shall be the only moving part and shall be securely mounted on an AISI 316 Stainless Steel stem. Lower grades of Stainless Steel shall not be acceptable. The Stainless Steel stem shall be provided with wrench flats for ease of assembly and maintenance. Wrench flats will be fully accessible when inner valve is assembled.

All pressure containing components shall be constructed of ASTM A536-65 / 45 / 12 ductile iron. Valves shall be provided with smooth frictionless motion and maximum low flow stability with actuation being achieved by the use of Rolling Diaphragm technology.

Telemetry can be used to stop and start pumps by monitoring the level of the reservoir or to close and open a valve with an actuator on the reservoir inlet pipe for gravity feed pipelines.

Special design measures must be implemented to ensure that pumping against a close valve does not occur.

The consultant shall submit the proposed method for reservoir level control for CoE's approval.

4.6.2.2 Isolating valves

Wedge gate type valves are preferred, with a minimum pressure rating PN16 standard left-hand closing.

Butterfly valves shall be considered in case where the pipe diameter is greater than 300 mm, with prior approval from Divisional Head: Projects Division.

4.6.2.3 Pressure reducing valves

As per **Annexure B** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

4.6.3 Water meters

A water meter, EMF type or similar, must be installed where the main supply pipeline enters the reservoirs site. This is to enable City of Ekurhuleni to do a water balance and identify possible leaks on the supply line.;

A water meter, EMF type or similar, must also be installed on the reservoir outlet for water management and / or billing purposes.

4.6.4 Bypass system

Where feasible, a bypass system must be installed for maintenance purposes within the reservoir site. The bypass must be fitted with a PRV (where required) as well as upstream and downstream isolating valves. The installation of a PRV on the bypass is dependent on the system operating pressure.

4.6.5 Potable Water sampling points

This section gives a guideline to the installation of potable water sample points for Water Quality to be able to take potable water samples at reservoirs , towers and other network points.

It is very critical for each reservoir complex to have a properly installed potable water sample point to enable Water Quality to take a quality sample to test the water for compliance against the legislated SANS 241 standard. These tests results are thereof audited by Water Affairs for Blue drop compliance.

The sample point:

- Ensure that a sample point is installed on the inlet and outlet of the reservoir unless otherwise requested.
- Ensure that the water is not stagnant at the new installed point of sampling.
- Where two reservoirs are situated on one site, each reservoir should have a sample point to sample and test the outgoing water.
- If a normal tap is used, requirements prefer a brass tap for enough sterilization of the sample point to take place.

- Water Quality prefers a Parker Brass Female Hydraulic Quick Connect Coupling BH2-61 1/4 coupling at the fixed installation points. **See Figure below**

- Where a Parker Brass Female quick connect BH2-60 coupling is used, Red polycop or polyethylene pipes should not be exposed to the sunlight if used in installation. **See Figure below**

- Where a sample point is installed against a wall or vertically upwards, the space between the tap and the surface should be at lease 500mm to ensure that the sample bottle can fit in-between.

Stand-alone sample point.

Where a stand-alone sample point is to be installed at any reservoir or any other site, the ideal sample point can be constructed in the following manner:

- Steel pipe must be about 500 mm high, and at least be 100mm or more in diameter and filled with concrete.
- Stand-alone pipe must be casted in a concrete base of approximately 1 m² or fixed to a base plate bolted into an existing concrete slab.

- The standpipe must be painted yellow for the purpose of positive identification. Special measures shall be implemented to prevent reservoir leaks. The consultant shall submit the design and specification in this regard for CoE's review

- The pipe diameter between the water pipe (from which the sample needs to be taken) and the sample tap have to be < 10 mm diameter

5 ELEVATED TOWER GUIDELINES

5.1 General requirements

Regardless of the shape and size of the tower, the aesthetics of the tower and site should blend in with the natural surroundings.

Due to corrosion problems all towers shall be concrete, with no painting of the external structure to facilitate ease of maintenance, unless otherwise approved by CoE.

Water towers must be equipped with the following:

- Inlet pipes;
- Outlet pipe;
- Scour chamber / pipe with a valve;
- Standard access manholes with a watertight, lockable cover raised 200mm above the roof top surface;
- Overflow pipe with the necessary discharge arrangements;
- Air vents – these should not give access to insects, birds or other contaminants;
- Access ladders mounted both inside and outside the tower;

5.2 Design Codes and Standards

The design of water towers and pipe works infrastructure within the CoE must comply with the following designed requirements, amongst others, according to the latest edition of the following Codes, Standards and Statutory Regulations: The SABS / SANS.

- SANS 10100: The structural use of concrete,
- SABS 0162-1: The structural use of steel;
- SANS 10160- Series -: The general procedures and loading to be adopted in the design of buildings;
- SANS 1200: Standardized Specification for Civil Engineering Construction; and
- BS 8007: 1978 – British Standard Code of Practice for Design of Concrete Structure for Retaining Aqueous Liquids.

5.3 Tower sizing

Sufficient storage must be provided to meet balancing requirements and to cater for emergency and/or planned shut-downs of the supply to the distribution system by CoE or Rand Water.

Table 15: Elevated Tower Storage requirements

Elevated Storage (Tower)	Capacity	Additional capacity for Fire Flow
One electrically driven duty pump, plus one identical electrically driven standby pump, plus automatically activated standby power generation independent of the electricity supply.	2 Hours of IPF	To be stored in Reservoir
One electrically driven duty pump, plus one identical electrically driven standby pump.	4 to 6 hours of AADD	To be stored in Reservoir

5.4 Supply rates

- The elevated tower pump sets should be sized to have a duty equivalent to the sum of the instantaneous peak and fire flow or instantaneous peak demand plus additional allowance of 10%, whichever is the greater.
- Where elevated storage (towers) can be supplied via gravity feed, a tower by-pass pipeline is recommended to supply the consumers directly during power failures. Where necessary, PRV should be installed on the by-pass to control the pressure in the water system downstream of the tower.

5.5 Structural design

5.5.1 Materials

- Concrete – Class 35/19 as minimum with minimum cement content of 420 kg/m³;
- SANS 1200: Standardized Specification for Civil Engineering Construction;
- Reinforcing Steel – 450 MPa yield strength; and
- Structural Steel – Grade 355W for hot rolled sections and Grade 355W for plates.

5.5.2 Pipework inside water towers

All pipework cast-in concrete and inside water towers shall be stainless steel grade 316L, lined and coated with epoxy. All other pipework will be in accordance with the requirements of **Annexure B** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

Flexible joints (i.e. couplings, Victaulic clamps or flange adaptors) are not allowed inside water towers.

5.5.3 Ventilation, access opening and ladders

The design shall make provision safe access into the water tower and adequate ventilation inside the tower. The ladder inside the tower shall be stainless steel grade 316L.

Ventilators shall be designed to allow sufficient air inlet but prevent entry of dirt, birds, insects and other objects that can affect the quality of water inside the water tower.

5.6 Pipework and valves

This section should be read in conjunction with **Annexure B** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

5.6.1 Inlet, outlet, overflow and scour pipework

- Towers must have dedicated inlet and outlet pipes – no common inlet and outlet pipe system shall be accepted;
- A water meter must be installed on the supply pipeline to the water tower;
- After the water meter, a chamber with FCV / ACV combination must be constructed to control / limit the flow to the designed AADD. This will also ensure valve closure when the tower reaches its full supply level. The system must be a duplicate to allow maintenance of the control valves without disrupting the operation of the tower;
- An isolating valve is required on each inlet to allow selective operation of the inlets if required;
- The inlet and outlet pipes shall be positioned to ensure good circulation of the water and prevent stagnant areas.

- Two outlets must be provided that will combine into a single pipe outside the tower. Isolating valves must be installed on each individual outlet to allow selective operation if required;
- An overflow pipe must be installed which will enter an inspection chamber;
- The overflow capacity shall be adequate to accommodate any possible inflow scenario in future, during periods where there will be no water flowing from the reservoir through the outlet and the level control is not working.
- A scour pipe must be installed with an isolation valve and the scour pipe to be linked to the overflow inspection chamber;
- The design shall provide for a channel system to transport the overflow water away from the tower site, without causing erosion, taking health and safety into consideration and to an area where it can do no harm to the public and environment. The consultant shall obtain CoE's approval for the proposed design.
- A scour pipe must convey water from the reservoir to the nearest existing storm water system; and
- The scouring capacity shall be adequate to empty a full reservoir in **6 hours**. The same requirements applicable to channel overflow water away from the water tower site also apply to scouring.
- A manual by-pass system must be included, should the need arise to completely isolate the water tower from the supply and distribution networks.

5.6.2 Valves

5.6.2.1 Level control

Hydraulic level control valves are preferred over valves with actuators as they do not require any electricity, require minimal maintenance and lower operating costs.

The following three types of hydraulic level control valves can be considered:

- Altitude level control: Can be used where the tower is supplied by a dedicated inflow with no off-takes on the supply pipeline.
- Float level control valve.
- Ultrasonic level control

The altitude level -, flow rate - and float level control valves for reservoir inlets shall have a float control pilot and have a pressure rating of Class 16 – flanges shall conform to SABS 1123 table 1 600 / 3.

The valve must be able to function as a two position control valve, either fully open or fully closed. The valve must also allow normal forward flow to fill the tower to the maximum level and then close drip-tight at the set-point. It must open to refill the tower once the level drops below a fixed level (normally 2 m below the TWL). This delayed opening feature ensures that the valve does not immediately open and subsequently close on a lowering reservoir TWL.

The altitude pilot system shall fully exhaust to atmosphere ensuring the valve opens fully, no modulating control shall be accepted.

Valves shall be hydraulically operated globe valves. The inner valve assembly shall be top and bottom guided by means of bearing bushings. The inner valve assembly shall be the only moving part and shall be securely mounted on an AISI 316 Stainless Steel stem. Lower grades of Stainless Steel shall not be acceptable. The Stainless Steel stem shall be provided with wrench flats for ease of assembly and maintenance. Wrench flats will be fully accessible when inner valve is assembled.

All pressure containing components shall be constructed of ASTM A536-65 / 45 / 12 ductile iron. Valves shall be provided with smooth frictionless motion and maximum low flow stability with actuation being achieved by the use of Rolling Diaphragm technology.

Telemetry can be used to stop and start pumps by monitoring the level of the reservoir or to close and open a valve with an actuator on the reservoir inlet pipe for gravity feed pipelines.

Special design measures must be implemented to ensure that pumping against a close valve does not occur.

The consultant shall submit the proposed method for reservoir level control for CoE's approval.

5.6.2.2 Isolating valves

Wedge gate type valves are preferred, with a minimum pressure rating PN16 standard left-hand closing.

Butterfly valves shall be considered in case where the pipe diameter is greater than 300 mm, with prior approval from Divisional Head: Projects Division.

5.6.3 Water meters

A water meter, EMF type or similar, must be installed where the main supply pipeline enters the reservoirs site. This is to enable City of Ekurhuleni to do a water balance and identify possible leaks on the supply line.;

A water meter, EMF type or similar, must also be installed on the reservoir outlet for water management and / or billing purposes.

5.6.4 Bypass system

Where feasible, a bypass system must be installed for maintenance purposes within the water tower site. The bypass must be fitted with upstream and downstream isolating valves.

5.6.5 Potable Water sampling points

This section gives a guideline to the installation of potable water sample points for Water Quality to be able to take potable water samples at reservoirs , towers and other network points.

It is very critical for each reservoir complex to have a properly installed potable water sample point to enable Water Quality to take a quality sample to test the water for compliance against the legislated SANS 241 standard. These tests results are thereof audited by Water Affairs for Blue drop compliance.

The sample point:

- Ensure that a sample point is installed on the inlet and outlet of the tower unless otherwise requested.
- Ensure that the water is not stagnant at the new installed point of sampling.
- Where two towers are situated on one site, each tower should have a sample point to sample and test the outgoing water.
- If a normal tap is used, requirements prefer a brass tap for enough sterilization of the sample point to take place.

- Water Quality prefers a Parker Brass Female Hydraulic Quick Connect Coupling BH2-61 1/4 coupling at the fixed installation points. **See Figure below**

- Where a Parker Brass Female quick connect BH2-60 coupling is used, Red polycop or polyethylene pipes should not be exposed to the sunlight if used in installation. **See Figure below**

- Where a sample point is installed against a wall or vertically upwards, the space between the tap and the surface should be at lease 500mm to ensure that the sample bottle can fit in-between.

Stand-alone sample point.

Where a stand-alone sample point is to be installed at any reservoir or any other site, the ideal sample point can be constructed in the following manner:

- Steel pipe must be about 500 mm high, and at least be 100mm or more in diameter and filled with concrete.
- Stand-alone pipe must be casted in a concrete base of approximately 1 m² or fixed to a base plate bolted into an existing concrete slab.

- The standpipe must be painted yellow for the purpose of positive identification. Special measures shall be implemented to prevent reservoir leaks. The consultant shall submit the design and specification in this regard for CoE's review

- The pipe diameter between the water pipe (from which the sample needs to be taken) and the sample tap have to be < 10 mm diameter

6 WATER PUMP STATIONS

6.1 General requirements

Water pump stations are designed to either pump water into a reservoir / water tower or to pump it directly into reticulation zones in order to maintain constant pressures within a zone. While pump stations pumping water into a reservoir / water tower will be controlled by level controllers, the latter will be controlled by pressure monitoring and pumps fitted with variable speed drives (VSD's).

Pump stations shall be easily accessible during all weather conditions.

To ensure proper operation of the pumps, the contractor shall be required to test and adjust all equipment after construction is completed. Pumps and motors shall be aligned and balanced on site per manufacturer's specifications / recommendations.

The following basic requirements are applicable:

- Aesthetic appearance and low-maintenance landscaping.
- Adequate service (water and electricity) connections.
- A concrete apron sloping away from the pump station.
- A washing slab draining into the wet sump.
- A 25 mm hose bib tap with a heavy duty garden hose capable of reaching the whole pump station.
- Access stairs / CAT ladders where necessary.
- Safe and sufficient storage areas for operational manuals, tools and lubricants
- To ensure a valid warranty, pump sets shall be supplied directly by the manufacturer or by authorized and licenced suppliers who shall provide the manufacturer's warranty services for the pump sets.
- Inlet works, dry / wet wells, suction and delivery pipework and rising main with all necessary pressure control and measurement features, surge protection systems, air-vacuum / release valves, isolation valves, couplings, odour control systems and other appurtenances required for a complete and operable system.
- Appropriate noise control system.
- Access road and parking, site security, lighting, drainage, signs and landscaping

6.2 Location and site selection

The following aspects must be addressed during the site selection process of a pump station:

- It must have minimum impact on the environment.
- It must be situated above the 1:50 year flood line.
- It must cause minimum inconvenience for those operating and maintaining it.
- It must have a minimum impact in the event of an emergency.

6.3 Pumps and motors

6.3.1 General

In general, dry well installations are preferred.
Split case centrifugal type pumps are preferred above multi stage pumps. Bronze or stainless steel impellers are also preferred. The pumps should be equiped with a Fenno flex or steel type coupling.

Base plates must be manufactured from mild steel plate of adequate thickness, galvanised according to SABS 1463. The base plate must allow the pump and motor to be easily removed without removing any part of the suction or delivery pipework.

Pump motors must be three-phase induction type, with embedded sensors for thermal detecting and cut out.

6.3.2 System hydraulics

Pump stations shall be designed to operate under the full range of projected system hydraulic conditions. Systems shall be designed to prevent pumps from operating for extended periods beyond the pump manufacturers' recommended normal operating ranges. Start / stop cycles shall be in accordance with the motor manufacturers' recommendation.

6.3.3 Surge analysis

Hydraulic surges and transients (water hammer) shall be determined during the design of pump stations and rising mains and the design of all relevant components shall take these pressures into consideration.

6.3.4 Cyclic fatique

The design shall take cyclic fatique due to cyclic pressures (pump starts and stops) into consideration.

6.3.5 Pump duty and number of pumps

The pump performance curves must be superimposed on the pipeline system curve to select a suitable pump operation duty point.A minimum of two pumps (1 x operating + 1 x standby) should be installed, operating alternatively, each capable of pumping the design flow. Standby pumps must be automatically activated if a duty pump or its driving motor fails due to mechanical failure. However, care must be taken not to provide excessive standby capacity.

At least one spare / standby pump must be provided, depending on the total number of pumps, with a capacity similar to the largest pump.

6.3.6 Efficiency

Pumps shall be selected to ensure that the specific duty point falls within the best efficiency performance / near the maximum efficiency point on the pump's characteristic curve, within the pump's recommended operating range and within the manufacturer's recommended limits for radial thrust and vibration.

6.4 Pump station layout

The design of the pump station shall make provision for adequate space for operation and maintenance and a safe working environment.

Hoisting equipment must be able to reach all equipment that cannot be handled by hand, with sufficient vertical space to lift and move the equipment to the outside of the pump station.

At least one access door shall be provided for man entry only and one for the removal of all equipment by truck.

Pump stations shall be protected from physical damage and remain operational during a 100-year flood.

It is preferred that pump floors be above ground level to prevent storm water flooding and to drain leaking water under gravity to the outside. Should it be necessary that the pump sets be installed below ground level (eg to increase the NPSH available), adequate provision must be made to pump storm water and leaking water out to prevent damage to equipment.

6.5 Noise control

The pumping station facility should meet the minimum noise level requirement of the local authority and the Occupational Safety and Health Act (Act 85 of 1993).

The following aspects should receive special attention during the design and positioning process:

- Minimizing the generation of sound energy as well as the reduction thereof by applying appropiate attenuation measures.
- Deflecting the sound energy away from sensitive areas.
- Minimizing the objectional characterisitcs of the sound.

6.6 Other mechanical and electrical items

6.6.1 Hoisting equipment

The sub-structure and superstructure must be designed to ensure that the installation and removal of equipment can be done with minimal effort. This may require provision for access hatches, lifting hooks, hoisting systems, roller shutter doors etc.

6.6.2 Ventilation

The pump station should ensure sufficient movement of fresh air by a suitable ventilation system to prevent damage to mechanical and electrical equipment due to overheating.

Sumps shall also be well ventilated to prevent build-up of dangerous gasses.

6.6.3 Standby generators

Where water pump stations require backup power a stand-by generator to supply the pump station with full load of power for a minimum of 6 hours in case the primary electrical supply is out of service.

Larger pump stations shall have permanent diesel-oil fuelled, engine-driven generator units with automatic transfer switches to transfer the electrical feed from the primary to the standby unit when a power failure is detected by the instrumentation and control system, sized to operate all electrical components. Generators must be fitted with a stainless steel diesel tank as well as an AMF (automatic mains failure) detection.

Determining the engine generator's size depends upon the requirements of starting and operating the pumps at peak possible load and all ancillary equipment in the pump station that could operate during a power outage.

6.7 Valves

Wedge type gate valves shall be permitted for diameters smaller than 600 mm with a minimum pressure rating PN16 to SABS 664, non-rising spindle and left hand closing. Butterfly valves shall only be considered for installations exceeding 450 mm in diameter.

Provision must be made for suitable air, scour, control and non-return valves as required by the design.

Butterfly valves shall not be allowed as pressure or flow control valves but can be used with an actuator to start or stop pumps against closed valves, but it must be either in a fully open or fully closed position.

The selection of the type of non-return valves shall take surges and transients into consideration.

For general valve descriptions and details, refer to **Annexure B** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

6.8 Pipework

- All pipework within the pump station must be flanged or welded.
- The class of pipes and associated flanges shall suit the design pressure (including surge and transient) with a minimum design pressure of 16 bar.
- The bell-mouth suction from a wet well should be sized to have a velocity less than 1.0 m/s.
- Inlet shall be designed to prevent forming of vortexes.
- The velocity in suction pipes may not exceed 1.5 m/s.
- The velocity in delivery pipes may not exceed 3.0 m/s.
- Restrained flexible couplings must be provided between the isolating valve and the pump on the suction pipe and between the pump and the non-return valve on the deliver pipe.
- Suction and delivery pipework shall be supported at 1.5 m intervals (maximum) and all changes in direction.

The pump station pipework must allow for easy removal of standby pumps and fittings without affecting the operation of the pump station.

A pressure gauge shall be installed on the suction and discharge side of each pump installed in a dry well. The range of discharge gauges shall be adequate to measure the shutoff head on the pump.

6.9 Water meters

Flow meters must be installed in accordance with the specifications of the manufacturer on delivery manifolds of the pump stations.

Provision shall be made for telemetry for remote monitoring purposes. The CoE prefers the following types of flow meters:

- in line ultrasonic flow meters;
- clamp on ultrasonic flow meters;
- flanged mechanical turbine meters and,
- electromagnetic flow meters.

The type of meter for each pump station to be agreed with CoE.

Flow meter installations shall make provision for straight pipe sections upstream and downstream of the meter to ensure the required meter accuracy. The length of these straight pipe sections shall be in accordance with the meter manufacturer's specifications/guidelines.

7 SEWER PUMP STATION

7.1 General requirements

The CoE will only consider municipal sewer pump stations in exceptional circumstances, after all other alternatives have been exhausted. Sewer pump stations must be avoided as far as possible and only considered if gravity transfer of sewage is not possible and / or feasible. Accordingly, the installation of sewer pump stations is strictly dependent on approval of CoE's HOD – Water and Sanitation Department.

Sewer pump stations normally pump sewage from gravity inlets into outfall sewer systems or into sewage treatment works via rising mains.

The design of sewer pump stations require special attention with regards to the environmental hazard caused by pump station failure. All reasonable and practical measures shall be implemented in the planning and design of these pump stations to minimise the incidence and effect of any pollution because of overflows from the pump station. Sewer pump stations shall also be located where the impact on residential areas and the environment will be an absolute minimum.

Pump stations shall be easily accessible during all weather conditions.

To ensure proper operation of the pumps, the contractor shall be required to test and adjust all equipment after construction is completed. Pumps and motors shall be aligned and balanced on site per manufacturer's specifications / recommendations.

The following other basic requirements are applicable:

- Aesthetic appearance and low-maintenance landscaping.
- Adequate service (water and electricity) connections.
- A concrete apron sloping away from the pump station.
- A washing slab draining into the wet sump.
- A 25 mm hose bib tap with a heavy duty garden hose capable of reaching the whole pump station.
- Access stairs / CAT ladders where necessary.
- Safe and sufficient storage areas for operational manuals, tools and lubricants
- To ensure a valid warranty, pump sets shall be supplied directly by the manufacturer or by authorized and licenced suppliers who shall provide the manufacturer's warranty services for the pump sets.
- Inlet works, dry / wet wells, suction and delivery pipework and rising main with all necessary pressure control and measurement features, surge protection systems, air-vacuum / release valves, isolation valves, couplings, odour control systems and other appurtenances required for a complete and operable system.
- Appropriate noise control system.
- Access road and parking, site security, lighting, drainage, signs landscaping and emergency storage.

7.2 Location and site selection

The following aspects must be addressed during the site selection process of a sewage pump station:

- It must have minimum impact on the environment.
- It must be situated above the 1:50 year flood line.
- It must cause minimum inconvenience for those operating and maintaining it.

- It must have a minimum impact in the event of an emergency.

7.3 Pumps and motors

7.3.1 General

Horizontal split case, centrifugal type / vertical pumps are preferred to multi stage pumps. Bronze or stainless steel impellers are preferred, although cast iron impellers are also commonly used. The pumps should be equiped with a Fenno flex or steel type coupling.

Pump motors must be three-phase induction type, with embedded sensors for thermal detecting and cut out.

7.3.2 Self-priming pumps

The selection of self-priming pumps must take the following aspects into consideration:

- The pump must be able to achieve the required duty at a rotational speed not exceeding 1 500 rpm.
- The suction inlet must be at least 100 mm diameter.
- The impellors must be of a non-clog type, able to pass solids of up to 75 mm in diameter.
- Base plates must be manufactured from mild steel plate of adequate thickness, galvanised according to SABS 1463. The base plate must allow the pump and motor to be easily removed without removing any part of the suction or delivery pipework.
- All bolts, nuts and washers shall be of 316 stainless steel.
- An appropriate size Fenner type tyre coupling or V-belts (with a Coupling Drive safety factor of 1.5), shall be used between the motor and the pump. The coupling shall be covered with a strong guard.
- The pump design must allow for sufficient clearance to remove blockages and provide easy access for service and repair without interrupting suction and discharge piping.
- The pump shall be equipped with a mechanical shaft seal by the manufacturers. The seal shall be oil-lubricated, double floating, self-aligning mechanical seal with the rotating and stationary seal faces, manufactured from tungsten titanium carbide. The seal shall be lubricated from an independent oil filled reservoir, fitted with a clear sight gauge to provide easy monitoring of the seal oil level and condition. Pump protection shall include an atmospheric vent between the mechanical seal chamber and the bearing chamber.
- The pump shall have a non-overloading power curve.
- Only electrical powered pumps are allowed.
- The electrical motors must be rated for continuous operation at an output of at least 10% (or the % proposed by the motor manufacturer whichever is the greater) more than the maximum power requirements of the pump when operating at the maximum duty.
- The maximum suction lift shall not exceed the pump manufacturer's recommendations. The suction lift shall be based on a net positive suction calculation with an adequate factor of safety.
- All self-priming pumps shall be fitted with manufacturer's custom air release valves that close on presence of pressure, not on presence of liquid only.
- Each pump shall be designed to retain adequate liquid in the pump casing to ensure unattended automatic re-priming while operating at its rated speed in a completely open system without suction check valves and with a dry suction leg.

7.3.3 Submersible pumps

In general, submersible pumps will not be permitted unless specifically approved in advance by the Head of Department: Water and Sanitation.

Should the use of submersible pumps be approved, it shall be installed on a guide rail system to allow for removal and installation of the pump without entering the wet well. Submersible pumps shall be easily removable and replaceable without dewatering the sump or disconnecting any piping in the sump.

Submersible pumps shall be designed specifically for raw sewage pumping applications and the following aspects must be taken into consideration:

- All slide rails, locating plates, lifting eyes and lifting ropes must be manufactured from grade 316L stainless steel.
- Each pump shall be equipped with a seal monitoring sensor.
- Each pump shall be equipped with a temperature sensor in the motor stator.
- Motors shall be non-overloading type under maximum demand, and have an S1 rating under these conditions.
- Drive-end bearings shall be angular contact type, preferably double row C3 with an expected bearing life of 50 000 hours.
- Rotor shaft shall be minimum 30 mm at impeller bore and shall be manufactured from 431 stainless steel material.
- No pump hosting mechanical seal or seal cavity in wet-end* will be accepted, as raw sewage will include rags, grit and sand which will be pumped. The use of a double, back to back mechanical seal in oil, is preferred.
- The wet-end* shall be manufactured from a wear resistant material, suitable for grit removal.
- The impeller shall be a non-clogging or open vortex type, as raw sewage will include rags, grit and sand.
- The required solid passing shall be a minimum of 75 mm spherical outside diameter.
- The suction and outlet of the pump shall not be smaller than 100 mm to prevent clogging at low hydraulic speeds
- The 100 mm duckfoot shall be the catalogued product for the specific pump, manufactured from high-grade cast iron.
- The duckfoot seal shall provide for sealing between slide shoe and duckfoot bend.

* Wet-end: all parts in contact with the raw sewage being pumped (i.e. rags, sand and grit).

7.3.4 System Hydraulics

The pump station must have sufficient capacity for pumping instantaneous peak and peak wet weather flows without overflowing the pump station or sewer system.

Pump stations shall be designed to operate under the full range of projected system hydraulic conditions. Systems shall be designed to prevent pumps from operating for extended periods beyond the pump manufacturers' recommended normal operating ranges. Start / stop cycles shall be in accordance with the motor manufacturers' recommendation.

7.3.5 Surge analysis

Hydraulic surges and transients (water hammer) shall be determined during the design of pump stations and rising mains and the design of all relevant components shall take these pressures into consideration.

7.3.6 Cyclic fatigue

The design shall take cyclic fatique due to cyclic pressures (pump starts and stops) into consideration. Especially for sewer pump stations where many pressure cycles could be experienced during the life time of the pump station, depending on the variance of inflow over time and the capacity of suction storage and other factors.

7.3.7 Pump duty and number of pumps

Pump stations shall be designed to accommodate peak wet weather flow.

The pump performance curves must be superimposed on the pipeline system curve to select a suitable pump operation duty point.

A minimum two pumps (1 x operating + 1 x standby) should be installed, operating alternatively, each capable of pumping the design flow. Standby pumps must be automatically activated if a duty pump or its driving motor fails due to mechanical failure. However, care must be taken not to provide excessive standby capacity.

At least one spare / standby pump must be provided, depending on the total number of pumps, with a capacity similar to the largest pump.

7.3.8 Efficiency

Pumps shall be selected to ensure that the specific duty point falls within the best efficiency performance / near the maximum efficiency point on the pump's characteristic curve, within the pump's recommended operating range and within the manufacturer's recommended limits for radial thrust and vibration.

7.3.9 Solids passing

Openings and passages of pumps shall be large enough to permit the passing of 75 mm diameter spheres. Impellers shall be "non-clog" type. Pump volute or casing shall contain no openings (recirculation ports, etc.) of a lesser diameter than the specified sphere sizes. No screens or any internal devices that interfere with priming and performance or create maintenance nuisance of the pump shall be allowed.

7.4 Pump station layout

The design of the pump station shall make provision for adequate space for operation and maintenance and a safe working environment.

Hoisting equipment must be able to reach all equipment that cannot be handled by hand, with sufficient vertical space to lift and move the equipment to the outside of the pump station.

At least one access door shall be provided for man entry only and one for the removal of all equipment by truck.
Pump stations shall be protected from physical damage and remain operational during a 100-year flood.

It is preferred that pump floors be above ground level to prevent storm water flooding and to drain leaking water under gravity to the outside. Should it be necessary that the pump sets be installed below ground level (e.g. to increase the NPSH available), adequate provision must be made to pump storm water and leaking water out to prevent damage to equipment.

7.4.1 Inlet works

The pump station inlet works must be designed to include the following:

- Adequate protection measures at inlets to protect pumping equipment against large solids in the effluent.
- Due consideration for the practical operation and maintenance of the protection screens, as approved by the CoE's Division Head: Projects and Operations Divisions.
- For small installations, where an automatic screening system will not be feasible, a 316L stainless steel / galvanised mild steel filter basket with/without a macerator (grinder).
- A sand trap system including a bypass for maintenance purposes.
- Interconnection with the bypass by means of a sluice gate configuration.

7.4.2 Sumps

The sump must be designed to include the following:

- Size to be based on the cycle time and the wet-well volume between start and stop elevations. It can be calculated as follows:

  $$V = \frac{TQp}{4}$$

  V = required wet-well capacity (m³)
  T = minimum time in minutes of one pumping cycle
  Qp = pump capacity (m³/min) or increment in pumping capacity
- The maximum number of motor starts per hour shall be as shown in **Table 16**.

Table 16: Recommended number of maximum pump starts

MOTOR (kW)	MAXIMUM STARTS PER HOUR	MINIMUM CYCLE TIME (MINUTES)
Up to 35	6	10
45 to 55	4	15
70 and larger	2	30

- To prevent formation of septic conditions and odours, a maximum of 10 min retention time at average design flows will be allowed.
- Inlet sewers are not allowed to be used as wet-well storage.
- No mixers are allowed.
- The two sumps must be interconnected by means of a valve / sluice gate configuration. An overflow to the emergency storage facility must be provided to allow the discharge of sewage in high water level conditions during power failures or blockage scenarios.
- To allow access to the sumps, CAT ladders with safety cages must be installed in each. The ladder shall be manufactured from 316L stainless steel. Step irons are not permitted.
- Access manholes of at least 900 x 900 mm must be provided for each sump.
- All equipment and fixtures in the sump shall be corrosion proof (stainless steel, unless otherwise specified and approved by the Division Heads: Projects and Operations Divisions.
- Sumps designs shall minimise solids build-up and shall be self-cleansing. Sumps shall either be trenched or hopper style, with side slopes of 45 degrees or steeper (60 degrees is preferred), to the inlet of the pumps.
- The base of the wet sump shall slope towards the pump inlet to enable the sewage to flow into the sump without forming deposits. All corners shall have a minimum benching of 45 degrees, however the angle may be reduced if the

section is flushed by a strong flow. As far as possible, the bottom area should be minimized and liquid volume below the pump stop level should be kept to a minimum.

- Sumps shall be designed to avoid air entrainment and low local flow velocities. A suitably sized bellmouth shall be installed the avoid the formation of vortexes and to eliminate suction cavitation.
- Sumps shall also be designed to prevent the occurrence of septic action during periods of extreme low flow. The dissolved hydrogen sulphide content of the wet well shall be maintained below 0,1 mg/l.
- The pump station shall be designed to avoid flooding of the sump and / or electrical installations by stormwater or other water infiltration.
- In order to prevent the pump station from floating, Anti-buoyancy measures shall be implemented where required.

7.4.3 Sump level control

For sewer pump installations, the level control mechanism shall be an ultrasonic level controller, together with a backup float mechanism. The ultrasonic sensing devices shall be located in the sump of the pump station where it will not be affected by flows entering the sump or by the suction of the pumps.

At a given water level, the first pump shall be activated to start. As the water level rises, subsequent pumps are activated to start one at a time. In cases where the water level raises extremely high, the standby pump must also be activated to start.

At a predetermined low water levels, pumps must be deactivated to stop.

7.4.4 Emergency overflow storage

Taking the environment, public etc. into consideration, adequate provision shall be made for emergency storage to accommodate sewage flow during periods when the pump station is out of operation due to power, maintenance or other reasons.

The consultant shall a design proposal for emergency storage to CoE for approval.

The following must be considered for emergency storage:

- Emergency storage must be provided for at least **6 hours** of ADWF which can either be provided in a concrete tank and / or dam, based on site constraints and economics.
- For small pump stations, the emergency storage capacity above the pump start-up level should be equivalent to the greater value of **24 hr** ADWF or **1 kl** (SANS 10252-2:1993)
- The maximum high level in the storage facility should be less than the lowest manhole in the system, upstream of the pump station.

7.5 Noise control

The pumping station facility should meet the minimum noise level requirement of the local authority and the Occupational Safety and Health Act (Act 85 of 1993).

The following aspects should receive special attention during the design and positioning process:

- Minimizing the generation of sound energy as well as the reduction thereof by applying appropiate attenuation measures.
- Deflecting the sound energy away from sensitive areas.
- Minimizing the objectional characterisitcs of the sound.

7.6 Odour control

A suitable odour control system must be installed for pump stations located near residential, business and/or other sensitive areas to pro-actively minimise odour. The design of the pump station must as far as possible control and eliminate potential odour generation at the source, with due consideration of the septicity and prevailing wind directions applicable at the pump station.

7.7 Other mechanical and electrical items

7.7.1 Hoisting equipment

The sub-structure and superstructure must be designed to ensure that the installation and removal of equipment can be done with minimal effort. This may require provision for access hatches, lifting hooks, hoisting systems, roller shutter doors etc.

7.7.2 Ventilation

The pump station should ensure sufficient movement of fresh air by a suitable ventilation system to prevent damage to mechanical and electrical equipment due to overheating.

Sumps shall also be well ventilated to prevent build-up of dangerous gasses.

7.7.3 Standby generators

All sewer pump stations must include a stand-by generator to supply the pump station with full load of power for a minimum of **6 hours** in case the primary electrical supply is out of service.

Larger pump stations shall have permanent diesel-oil fuelled, engine-driven generator units with automatic transfer switches to transfer the electrical feed from the primary to the standby unit when a power failure is detected by the instrumentation and control system, sized to operate all electrical components. Generators must be fitted with a stainless steel diesel tank as well as an AMF (automatic mains failure) detection.

Determining the engine generator's size depends upon the requirements of starting and operating the pumps at peak possible load and all ancillary equipment in the pump station that could operate during a power outage.

7.8 Valves

Wedge type gate valves shall be permitted for diameters smaller than 450 mm with a minimum pressure rating PN16 to SABS 664, non-rising spindle and left hand closing. Butterfly valves shall only be considered for installations exceeding 600 mm in diameter.

Provision must be made for suitable air, scour, control and non-return valves as required by the design.

Sewage specific air valves shall be provided at critical locations in the pump station and delivery line. The valves shall prevent air being captured inside the piping system or prevent collapse of the piping system during vacuum conditions.

Butterfly valves shall not be allowed as pressure or flow control valves but can be used with an actuator to start or stop pumps against closed valves, but it must be either in a fully open or fully closed position.

The selection of the type of non-return valves shall take surges and transients into consideration and shall be suitable for sewage.

Gate valves and NRV's shall be installed above the natural ground level or in a separate dry chamber next to a wet sump. The NRV shall be set at a level higher than the water level. Each pump shall have its own gate valve / NRV arrangement. For submersible pumps, the valves and check valves must be installed in a separate box outside the wet sump and access from the natural ground must be easy.

For general valve descriptions and details, refer to **Annexure B** of CoE' "Guidelines and Standards for Planning and Design of Water and Sanitation Services".

7.9 Pipework

- All pipework within the pump station must be flanged or welded.
- The class of pipes and associated flanges shall suit the design pressure (including surge and transient) with a minimum design pressure of 16 bar.
- Inlet shall be designed to prevent forming of vortexes.
- The velocity in suction pipes may not exceed 1.0 m/s.
- The velocity in delivery pipes may not exceed 1.4 m/s.
- Adequate allowance for space between pumps shall be made to avoid suction interference.
- Restrained flexible couplings must be provided between the isolating valve and the pump on the suction pipe and between the pump and the non-return valve on the deliver pipe.
- Suction and delivery pipework shall be supported at 1.5 m intervals (maximum) and all changes in direction.

The pump station pipework must allow for easy removal of standby pumps and fittings without affecting the operation of the pump station.

A pressure gauge shall be installed on the suction and discharge side of each pump installed in a dry well. The range of discharge gauges shall be adequate to measure the shutoff head on the pump.

7.10 Water meters

Clamp-on ultrasonic flow meters or full bore electromagnetic flow (EMF) meters shall be installed on delivery manifolds of sewer pump stations.

Provision to be provided for telemetry for remote monitoring purposes.

Flow meter installations shall make provision for straight pipe sections upstream and downstream of the meter to ensure the required meter accuracy. The length of these straight pipe sections shall be in accordance with the meter manufacturer's specifications/guidelines.