TECHNICAL SPECIFICATION

DB: BOREHOLE DRILLING & EQUIPPING

CONTENTS

DB 01 SCOPE

This specification covers borehole drilling procedures, casing, backfilling, stabilising, protection and recording and reporting of related activities with the drilling of a borehole. The function of drilling of a borehole shall be supply of raw water to the facility at hand.

DB 02 STANDARD SPECIFICATIONS

DB 02.01 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act, 1993 (Act no 85 of 1993) shall be adhered to.

DB 02.02 MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

DB 02.03 MUNICIPAL REGULATIONS, LAWS AND BY-LAWS

All municipal regulations laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

DB 02.03 DWAF GUIDELINES

Minimum Standards and Guidelines for Groundwater Resource Development for the Community Water Supply and Sanitation Programme issued by the Department of Water Affairs and Forestry shall be adhered to unless otherwise specified.

DB 03 CONTRACTOR'S RESPONSIBILITY AND APPROACH

It is required that the drilling of any borehole be approached with due diligence and care on the part of the appointed drilling contractor. Specifically, it is required that the drilling of each borehole be approached on the premise that it will be successful and, as such, will serve the function of a raw water supply to the facility at hand. Under normal circumstances, the pre-drilling of a small diameter pilot borehole will not be allowed. Such an approach may only be considered with the approval of the Hydrogeological Consultant who shall be required to fully motivate such an approach to the Implementing Authority.

The Drilling Contractor shall function under the direct supervision of the Hydrogeological Consultant. This by no means implies that the Drilling Contractor is absolved from any responsibility. All drilling activities shall, therefore, be approached through communication and discussion between the Hydrogeological Consultant and the contractor with a view to developing the most suitable and mutually acceptable finished product serving the best interests of the project.

Failure by the contractor to timeously render advice and input where required shall be regarded as a dereliction of duty. This responsibility extends to informing the Hydrogeological Consultant of serious reservations regarding any aspect of the work. The contractor shall also be required to maintain the aesthetic appearance of the site during drilling operations, including keeping the site neat, tidy and free of litter. The contractor shall ensure that safety standards are met and that the work site is kept free, as far as is possible, from vehicular and pedestrian traffic and from interested bystanders and onlookers not involved with the project.

The appointed Drilling Contractor shall carry the final responsibility for the finished water supply borehole and all actions and activities leading up thereto.

DB 04 DRILLING PROCEDURE

DB 04.01 WORKMANSHIP & PERFORMANCE

The standard of workmanship of the Drilling Contractor shall be subject to close scrutiny by the Hydrogeological Consultant. Although it cannot be expected of the contractor to complete a specified number of boreholes in a given time period, it is reasonable to expect that "favourable progress" be made under normal circumstances and drilling conditions. An indication of what might be regarded as "favourable progress" is considered to fall in the range of 50 to 100 m of drilling advancement per day taking into consideration interhole moves and setup time.

Although work-in-progress may be completed, the contractor shall under no circumstances vacate a site before the Hydrogeological Consultant has inspected the completed works and provided written approval that the work executed conforms to the requirements of this specification.

DB 04.02 DRILLING TECHNIQUE

The drilling technique to be employed for the project at hand is that of rotary air percussion drilling employing a down-the-hole (DTH) hammer.

Depending on site-specific circumstances other techniques might be employed including: (1) mud rotary drilling, (2) Odex drilling, (3) dual-tube reverse circulation and (4) cable tool percussion drilling. Instances where another drilling technique might be considered more appropriate and efficient shall be identified by the Hydrogeological Consultant during the project and the Contractor informed accordingly.

DB 04.03 EQUIPMENT AND MATERIAL

The equipment made available by the Drilling Contractor shall be in good working order. Equipment shall be maintained in good condition for the duration of the project. Routine servicing and preventative maintenance of all equipment required for the drilling procedure and other ancillary equipment shall form the responsibility of Contractor and shall be deemed as included in the tendered rates.

The drilling equipment shall include a full air/foam pumping system. At the start of the project, the gauge diameter of the button drill bits to be employed with the rotary air percussion drilling technique shall conform closely to their manufactured gauge and shall also possess all of their tungsten carbide buttons.

The Hydrogeological Consultant shall discuss with the Drilling Contractor the retirement of a bit due to excessive wear or damage incurred during the course of the project. Further, it is imperative that the equipment be of a suitable size and capacity to deal, on occasion, with: (1) deep boreholes (up to 200 m), (2) larger than average borehole diameters (up to 254 mm), (3) large quantities of groundwater and (4) potentially onerous drilling conditions. Since this capability is provided in large measure by the air compressor, it is considered that a compressor having a capacity of at least 2400 kPa (24 bar) and a volume of at least 750 cfm is appropriate for most water borehole drilling applications and conditions using the rotary air percussion technique. In order to maintain the straightness of a borehole, the Hydrogeological Consultant may insist that the drilling contractor employ at least an overshot sleeve (drill collar) fitted to the pneumatic DTH hammer. Further precautions to ensure this aspect might include the use of a stabiliser rod immediately behind the bit/hammer/overshot combination. All materials to be used on the project should be new and meet project specifications.

Steel casing shall be: (1) of the seam-welded type, (2) round, (3) straight, (4) of uniform wall thickness and (5) have bevelled edges. Second-hand material such as steel casing recovered from an earlier borehole can be used provided that it has been refurbished to an acceptable condition. The Hydrogeological Consultant shall have the right to reject, with motivation, any material (including casing) that is deemed inappropriate, substandard or otherwise unsuitable for the project.

DB 04.03 BOREHOLE CONSTRUCTION

This sections addressed certain basic borehole construction practices which will contribute to final acceptance of the successfully finished product.

DB 04.03.01 DRILLING DIAMETER

Drilling of the water supply borehole shall commence at a diameter, which shall allow for the trouble free insertion of casing. Under normal circumstances, this entails drilling a 203 mm (8") or 216 mm (8½") diameter bore through the weathered overburden and any other potentially unstable near surface material. The bore shall penetrate at least three meters into fresh, more competent material before this horizon can be secured from potential collapse or wash-out by casing it off with nominal 165 mm (6½") or 152 mm (6") diameter steel casing. Thereafter, the bore is continued at 165 mm (or 152 mm) drilling diameter to its completion depth.

The presence of unstable rock formations (which are often also associated with groundwater-bearing horizons) at greater depths in the bore generally account for complications, which shall impact, on the abovementioned approach. The Drilling Contractor shall firstly attempt to penetrate through such horizons in order establish their vertical thickness. Such horizons often possess only a temporary instability and become "cleaned out" as drilling advances. In instances where such horizons remain unstable and severely hamper drilling progress, it will become necessary for the contractor to remove the surface casing and ream (widen) the borehole to a diameter of at least 203 mm (or 216

mm) to the depth of such unstable horizon. It will then be required to re-insert 165 mm (or 152 mm) nominal diameter casing to this depth and attempt to advance this casing through the unstable horizon.

In exceptional circumstances it may even be necessary to re-drill or ream the borehole to a diameter of 254 mm through unstable overburden material, insert nominal 203 mm (or 216 mm) diameter casing through this horizon and widen the borehole to 203 mm (or 216 mm) diameter below this depth to the unstable zone. Extremely onerous drilling conditions at depth might even warrant the commencement of drilling at a diameter of 305 mm or greater. This approach is often taken when aiming to maximise the exploitation of groundwater from a productive karst aquifer.

Information regarding the dimensions of the more commonly used button drill bits for rotary air percussion drilling is given in Table DB.1 together with casing diameters generally associated with each bit gauge.

Table DB.1. Dimensions of commonly used button drillbit gauge diameters for use with the rotary air percussion drilling method

BIT GAUGE DIAMETER	CASING INSIDE DIAMETER FOR DRILL-THROUGH PURPOSES
127 mm (5 in.)	143 to 146 mm
152 mm (6 in.)	156 to 159 mm
165 mm (6½ in.)	168 to 171 mm
203 mm (8 in.)	207 to 212 mm
216 mm (8½ in.)	
254 mm (10 in.)	257 to 264 mm
305 mm (12 in.)	

NOTE:

1. The bit gauge diameter is also given in the Imperial unit of inches (in.) since this unit is still in common use when referring to this parameter.
2. Casing inside diameter varies according to wall thickness (refer Table DB.2).

The information provided in Table DB.1 shows that each bit gauge passes comfortably through casing with a similar nominal diameter. For example, a 203 mm gauge bit can be used to extend the depth of a borehole already equipped with 207 to 212 mm inside diameter casing without having to reduce to the next smallest drilling diameter. Note also that a borehole drilled to a given diameter is able to accept casing having the next smallest diameter. For example, a 203 mm diameter borehole can be fitted with either 152 mm nominal inside diameter or preferably 165 mm nominal inside diameter steel casing.

In view of the foregoing, it is clear that the minimum final cased diameter of a successful raw water supply (for the extent of the facility at hand) borehole shall seldom be less than 152 mm nominal.

DB 04.03.02 STEEL CASING

Steel casing may either be used in a temporary manner or form a permanent part of the borehole infrastructure. Its temporary use is indicated in instances where, for example, the borehole is unsuccessful or the need for it to remain in place becomes redundant. Under these circumstances it is also referred to as a pre-collar, surface casing, starter casing, outer casing or soil casing generally to be removed (recovered) on completion of drilling. It shall be left in place where the Hydrogeological Consultant is of the opinion that the unsuccessful borehole should be secured to serve a long-term groundwater monitoring purpose. In such instances, additional provision shall be made to protect the borehole against actions, which may compromise this function.

Steel casing shall be: (1) of the seam-welded type, (2) round, (3) straight, (4) of uniform wall thickness and (5) have bevelled edges. Secondhand material such as steel casing recovered from an earlier borehole can be used provided that it has been refurbished to an acceptable condition. The Hydrogeological Consultant shall have the right to reject, with motivation, any material (including casing) that is deemed inappropriate, substandard or otherwise unsuitable for the project.

More commonly, however, this casing constitutes the final casing with which a successful borehole is equipped. Its proper installation, therefore, is mandatory. It is installed from surface through unstable, unconsolidated or fractured materials usually occurring in the near surface. Under these circumstances, the function of steel casing includes one or more of: (1) supporting unstable materials against collapse into the borehole during drilling, (2) facilitating the installation or removal of other casing, (3) minimising the erosion and widening of the unstable upper portions of the borehole sidewall caused by the return flow established during drilling and/or the passage of drilling equipment/tools and (4) facilitating the placement of a sanitary seal and/or gravel pack or formation stabiliser.

In order to ensure as far as is possible that the annular space between this casing and the borehole sidewall remains open for the later emplacement of a sanitary seal, the circumferential entrance to this space shall be temporarily plugged. Hessian sacking packed around and lightly tamped into the surface entrance to this annular space can be used for this purpose. In instances where steel casing needs to be driven through unstable horizons (generally at greater depths in a borehole), it will be also be required that such casing be fitted with a casing shoe to protect the "mouth" of the casing from damage. Irrespective of the casing used to facilitate the drilling of the borehole, the final cased diameter of the finished product shall be sufficient for the borehole to easily accept a borehole pump. Since the outside diameter of the latter are generally in the order of 100 mm, it is required that the final cased diameter of the borehole not be less than 152 mm (6 in.) nominal where steel casing is used. Information on the dimensions of the more commonly used steel casing available locally is given in Table DB.2.

Table DB.2. Dimensions of commonly used and locally available steel borehole casing

OUTSIDE DIAMETER	WALL THICKNESS	INSIDE DIAMETER
165 mm (6 in. nominal)	3.0 mm 4.0 mm 4.5 mm	159 mm 157 mm 156 mm
177 mm (6½ in. nominal)	3.0 mm 4.0 mm 4.5 mm	171 mm 169 mm 168 mm
219 mm (8 in. nominal)	3.5 mm 4.5 mm 6.0 mm	212 mm 210 mm 207 mm
273 mm (10 in. nominal)	4.5 mm 6.0 mm 8.0 mm	264 mm 261 mm 257 mm

NOTES:
1. The casing outside diameter dimensions are also given in the Imperial unit of inches (in.) since this unit is still in common use when referring to this parameter.
2. Use of the term "nominal" when referring to casing diameter provides a direct association with the gauge of the bit (Table DB.1) which most closely passes through it.

DB 04.03.03 **CASING SHOE**

This item is fitted (welded) to the bottom end (foot) of a casing string in order to protect the "mouth" of the casing from damage due to forcing the casing through unstable horizons. Its use is therefore only warranted (indeed mandatory) in instances where such conditions reveal themselves to require securement through the emplacement of casing.

DB 04.03.04 **uPVC CASING**

Also referred to as thermoplastic casing, the material generally comprises PVC (polyvinyl chloride) which, when treated to withstand ultraviolet radiation, is known as uPVC casing. Its application in the construction of water supply boreholes is specific, being used mainly in instances where security against the collapse of a borehole sidewall is required and where steel casing does not already offer such security. In such instances, the casing is inserted the entire length of the borehole and will certainly be perforated for some portion of its length.

The diameter of this casing will also necessarily be smaller than that of the steel casing used which, in most instances, will have a nominal diameter of 165 mm. In order not to compromise too severely on the minimum nominal diameter requirement of 152 mm for successfully completed water supply boreholes, the inside diameter of the uPVC casing shall not be less than 128 mm with a wall thickness of 6 mm. It is also common practice to leave the steel casing in place in order to provide protection for the uPVC casing. The decision to use uPVC casing in the final construction of a borehole shall be made by the Hydrogeological Consultant.

DB 04.03.05 **PERFORATED CASING**

For the purposes of this project perforated casing used shall be of a prefabricated type. As a general guideline, slots should be: (1) 300 mm in length, (2) 3 to 4 mm wide, (3) positioned in bands around the circumference of the casing, (4) spaced equally in each band, (5) each circumferential band of slots separated by 100 mm of plain pipe, (6) every second band of slots aligned with one another and (7) a 300 mm section of plain pipe left at both ends of the casing.

Bearing in mind that the number of slots forming each circumferential band depends not only on the casing diameter but also impact on the strength of the casing, it is suggested that the guidelines presented in Table DB.3 be adhered to in this regard.

Table DB.3. Recommended number of slots per circumferential band for various steel casing diameters and associated percentage open area provided

NOMINAL CASING DIAMETER	NUMBER OF SLOTS PER CIRCUMFERENTIAL BAND	PERCENTAGE OPEN AREA
152 mm	6	3.0%
165 mm	8	3.7%
203 mm	10	3.7%

Also presented in this table (Table DB.3) is the approximate open area provided by the above slot pattern applied to each of the given casing diameters. In certain instances, however, it may be required to use more sophisticated and expensive slotted casing. Also known as screens, these include: (1) continuously wound wedge wire screens, (2) louvered screens or bridge-slotted screens and (3) screens pre-coated with gravel. The decision to use such screens shall again be made by the Hydrogeological Consultant after providing motivation to and gaining acceptance from the Implementing Authority.

DB 04.03.06 **RECOVERY OF STEEL CASING**

The contractor shall make every effort to recover, only on instruction from the Hydrogeological Consultant, steel casing from unsuccessful or abandoned boreholes. This casing can also be refurbished to an acceptable condition for re-use.

DB 04.03.07 **BOREHOLE STRAIGHTNESS**

The Drilling Contractor in the presence of the Hydrogeological Consultant shall perform the straightness test and its success (or failure) recorded by this party.

A borehole, which fails a straightness test, shall be deemed lost and it shall be required of the Drilling Contractor to drill a replacement borehole at own

expense. In the event that a straightness test is made before completion of the borehole, then the contractor shall be required to cease operations and facilitate access to the borehole for the duration of such activity.

DB 04.03.08 **BOREHOLE VERTICALITY**

The Hydrogeological Consultant in the presence of the Drilling Contractor shall perform the verticality test. The consultant shall therefore be required to provide the necessary equipment for conducting a verticality test. A borehole, which fails a verticality test, shall be deemed lost and it shall be required of the contractor to drill a replacement borehole at own expense. In the event that a verticality test is made before completion of the borehole, then the Drilling Contractor shall be required to cease operations and facilitate access to the borehole for the duration of such activity.

DB 04.03.09 **BACKFILLING**

This entails filling the annular space between the borehole sidewall and the outside of the casing with suitable material. The purpose of annular backfilling includes: (1) the provision of a base on which to found a sanitary seal and (2) the provision of support for the sidewalls of the borehole and the casing. In instances where casing has been seated at a comparatively shallow depth in fresh material below a weathered near-surface horizon, all of the drill cuttings removed from the borehole whilst drilling represents suitable material for this purpose. Annular backfilling with this material is not advisable in instances where this is not the case, such as for example where the casing extends to a substantial depth and comprises slotted/perforated sections or where the water-bearing horizon is shallow and open to the borehole via slotted/perforated casing. In these instances, it shall be required to insert a formation stabiliser into the annulus. The backfilling shall extend to within approximately 5 m of the ground surface.

The Contractor shall allow for the cost of backfilling in the tendered rates.

DB 04.03.10 **FORMATION STABILISER**

This comprises material, which is placed in the annulus between the borehole sidewall and perforated/slotted sections of casing to stabilise the formation against collapse and ingress into the borehole. The drill cuttings and spoils removed from the borehole is not suitable material for this purpose. The stabiliser shall comprise material which is: (1) well sorted, (2) well rounded, (3) low in calcareous content and (4) graded such that the smallest grain size is larger than the casing perforations/slots. The stabiliser material can either be placed by hand or through a tremie pipe. Excessive bridging of stabiliser material in the annulus can be prevented: (1) through the use of centralisers on the casing or (2) by washing it in with clean water. The formation stabiliser should extend some 10 m above the top of the uppermost perforated/slotted section of casing before the borehole is developed.

The Contractor shall allow for the cost of formation stabilising in the tendered rates.

DB 04.03.11 **CONCRETE COLLAR**

The Drilling Contractor shall construct a shallow circular concrete collar around each successfully completed borehole. This collar shall have dimensions and volume as specified by the Hydrogeological Consultant. The concrete mixture shall required strength of some 30 MPa after 28 days. A similar collar may need to be constructed, on request of the Hydrogeological Consultant, over unsuccessful or abandoned boreholes.

The Contractor shall allow for the cost of the concrete collar in the tendered rates.

DB 04.03.12 **UNSUCCESSFUL AND ABANDONED BOREHOLES**

A borehole shall be declared unsuccessful at the discretion of the Hydrogeological Consultant. The latter may also, at any time during the course of the work, order the abandonment of a borehole in progress.

In such instances, the Hydrogeological Consultant shall instruct the Drilling Contractor on further actions to be taken. These may include either: (1) the salvage of any casing from the borehole and (2) the plugging of the borehole or (3) the securement of the borehole for long term monitoring purposes, in which it case it shall be provided with a sanitary seal concrete collar protection and marking.

Plugging (or finishing) of an unsuccessful or abandoned borehole is aimed at removing any danger or hazard such boreholes may present to the environment, eg. as a conduit for the inflow of surface water into the groundwater regime or as a danger to traffic (whether human, stock or vehicular) in the immediate vicinity thereof. It shall also be required to cast a concrete collar over the infilled borehole.

The Drilling Contractor shall be remunerated for an unsuccessful or abandoned borehole on the basis of tendered rates in the Schedule of Rates for such of the following items as are relevant: (1) drilling per linear metre of depth for each relevant drilling diameter employed, (2) steel casing per linear metre thereof recovered, (3) backfilling, (4) a sanitary seal, (5) borehole protection and (6) borehole marking. Payment for any casing left behind in an unsuccessful or abandoned borehole will only be made, on the same basis as described in (2) above, on written certification by the Hydrogeological Consultant that the contractor has made every reasonable attempt in this regard.

DB 04.03.13 **LOST BOREHOLES**

A borehole shall be declared lost by the Hydrogeological Consultant in the event that it can not be completed satisfactorily due to factors such as: (1) the irrecoverable loss of drilling equipment, materials or tools therein, (2) accident to plant or heavy machinery, (3) failure to pass a straightness test and (4) failure to pass a verticality test. A decision in this regard shall be made after consultation with the Drilling Contractor, who shall have the considered option to either attempt remediation of the situation to the satisfaction of the Hydrogeological Consultant or, alternatively, declare the situation irretrievable.

No payment shall be made for any work done, materials used or time spent by the Drilling Contractor on a lost borehole. The cost of any materials recovered in a damaged state from a lost borehole shall be borne by the contractor.

A borehole, which is declared lost, shall be replaced with a new borehole to be constructed by the Drilling Contractor in the vicinity of the lost borehole and at a position indicated by the Hydrogeological Consultant. Payment for a new borehole constructed under these circumstances shall be made on the same basis as for any other successfully completed borehole. Materials recovered in good condition may, however, be re-used by the contractor.

DB 04.03.14 **SANITARY SEAL**

Every successful water supply borehole shall be provided with a sanitary seal. The seal shall consist of portland cement mixed to slurry with bentonite and water, which is free of oil and other organic matter. The bentonite and water should be thoroughly mixed in the ratio of 2 kg bentonite to 25 l water prior to adding and mixing in 50 kg (one bag) cement. The final grout seal shall extend to a depth of at least 5 m below ground surface, ie. founded on the backfilling. In such shallow applications, the slurry can be gravity-fed into the annulus through a small diameter tube (tremie pipe) extending to the depth of emplacement. The tremie pipe should be withdrawn slowly as the slurry fills up the annulus. There shall be no voids in the sanitary seal.

The Contractor shall allow for the cost of the sanitary seal in the tendered rates.

DB 04.03.15 **BOREHOLE DEVELOPMENT**

The Geohraulogist shall submit proof of sufficient borehole development procedures. This activity shall be concluded with the collection of a 1liter representative water sample obtained from the return flow during development.

The Contractor shall allow for the cost of borehole development in the tendered rates.

DB 04.03.16 **BOREHOLE DISINFECTION**

The Geohraulogist shall submit proof of sufficient borehole disinfection procedures.

Guideline volumes/weights of common compounds to be used for disinfection purposes under most normal circumstances can be derived from the information provided in Table DB.4.

The Contractor shall allow for the cost of borehole disinfection in the tendered rates.

Table DB.4. Guideline volumes/weights of common sterilants to be used per unit volume of water for various borehole diameters

	VOLUME OF WATER PER METRE OF BOREHOLE	VOLUME/WEIGHT OF STERILANT TO BE USED FOR DISINFECTION PER UNIT VOLUME OF WATER BELOW GROUNDWATER REST LEVEL		
		Sodium hypochlorite	Calcium hypochlorite	Chlorinated lime
	18 l	500 ml (2 cups)	26 g (¼ cup)	90 g (1 cup)
	21 l	600 ml (2½ cups)	30 g (_ cup)	105 g (1 cup)
	33 l	940 ml (4 cups)	47 g (½ cup)	165 g (1½ cups)
	51 l	1500 ml (6 cups)	73 g (¾ cup)	255 g (2½ cups)

NOTES:

1. No distinction is drawn between open and cased portions of a borehole since these differences are considered to have a negligible impact on calculated unit volumes.
2. The trade percentage of chlorine in the listed sterilants is taken to be: 3.5 percent by volume (35 ml/l) for sodium hypochlorite, 70 percent by weight (700 g/kg) for calcium hypochlorite, and 20 percent by weight (200 g/kg) for chlorinated lime.

EXAMPLE:

A 100-metre deep borehole with a nominal diameter of 165 mm and with a rest water level standing at a depth of 25 m below surface will require 75 x 30 g = 2,250 g (2.25 kg), alternatively 75 x _ cup = 25 cups, of calcium hypochlorite to achieve adequate disinfection. The same situation would require 75 x 600 ml = 45,000 ml (45 l) of sodium hypochlorite to achieve adequate disinfection.

DB 04.03.17 **BOREHOLE PROTECTION**

This entails sealing the borehole from the introduction of foreign material directly through the casing.

In order to provide the Hydrogeological Consultant with ready access to the borehole for water level measuring purposes, it is required that a small hole be drilled in the lid. This hole shall be furnished with a tamper-proof plug such as a "dead-end" threaded into a water pipe connector welded on the hole. The final diameter of the hole providing access to the borehole shall be sufficient to allow a "normal" dipmeter probe to pass through it. It is considered that a diameter of at least 10 mm and not more than 20 mm is suitable for this purpose.

The Contractor shall allow for the cost of borehole protection in the tendered rates.

DB 04.03.18 **BOREHOLE MARKING (IN THE FIELD)**

The activity itself represents marking the borehole by: (1) script-welding its assigned and unique identifying number onto the lid of the borehole and (2) planting a concrete block with dimensions of 200 mm x 200 mm x 200 mm (also bearing the number of the borehole) in the ground a distance of five metres to the north of the borehole.

It is the responsibility of the Hydrogeological Consultant to ensure that a borehole number is provided to the contractor for this purpose.

The Contractor shall allow for the cost of borehole marking in the tendered rates.

DB 04.03.19 **SITE FINISHING**

The activities associated with this task shall include the repair of construction scars on the work site resulting from drilling activities as well as the general cleanup of the site of waste materials, debris and oil spills. The latter shall be shoveled over and worked into the ground wherever possible.

Site finishing shall be deemed as included in the tendered rates.

DB 04.04 **DATA RECORDING AND REPORTING**

A detailed and accurate record of all information arising from the borehole drilling activity shall be recorded with care and diligence. The Drilling Contractor can collect much of this information. The Hydrogeological Consultant shall keep this current and available for inspection on request.

The contractor shall include the cost of data recording and reporting in the tendered rates.

It shall be the responsibility of the Hydrogeological Consultant to verify receipt of this information prior to certifying a claim by the Drilling Contractor in this regard. The following items of information represent the minimum number of parameters, which shall be monitored and recorded by the contractor:
Penetration Rate
Formation Sampling and Description
Water Strike Depth
Blow Yield
Groundwater Rest Level

DB 04.05 **DOWN-THE-HOLE LOSS OF EQUIPMENT**

The Hydrogeological Consultant shall afford the contractor every opportunity and reasonable time to fish for lost equipment. The Drilling Contractor shall, in turn, keep the Hydrogeological Consultant informed of progress and the likelihood of success in this regard. The contractor shall have no claim against any other party for any losses incurred in this regard. The Hydrogeological Consultant shall finally decide on the fate of the borehole. It may either be declared successful or lost.

DB 04.05.01 **BOREHOLE DECLARED SUCCESSFUL**

Circumstances under which a borehole may be declared successful include: (1) the borehole has encountered significant water, (2) pumping equipment can be installed to an acceptable depth in the borehole and (3) the lost equipment does not pose a threat to the present and future quality of the groundwater. In the event that a borehole is declared successful despite the irrecoverable loss of drilling equipment, materials or tools therein, then the exact nature and position of the equipment lost in the borehole shall be recorded and appear in relevant project documentation. The Drilling Contractor shall be remunerated for a borehole declared successful under these circumstances on the same basis as for any other successfully completed borehole.

DB 04.05.02 **BOREHOLE DECLARED LOST**

Refer to paragraph DB 04.03.13.

DB 04.06 **BOREHOLE INFORMATION REQUIRED**

A detailed and accurate record of all information arising from the following activities shall be submitted by the Hydrogeological Consultant.
Down-the-hole borehole measurement
Borehole Construction Information
Geological Information
Hydrogeological Information
Hydrochemical Information

The Contractor shall allow for the cost of the information in the tendered rates.

DB 04.07 **REHABILITATION OF EXISTING BOREHOLES**

The scope of this work may vary from the basic cleaning out and re-development of an existing borehole to the recovery of casing, the reaming and subsequent re-installation of casing. The nature of the rehabilitation required in each individual instance shall be identified prior to undertaking this activity since this shall indicate which equipment will most suitably complete the task.

The rehabilitation of an existing borehole shall be carried out under the supervision of the Hydrogeological Consultant. In any event, the execution of such work shall be subject to the same degree of data collection and record keeping as is required of a new borehole.

The Drilling Contractor shall be remunerated for this service on the basis of the rates tendered as per section DB 05. It shall be expected of the contractor to have assessed the potential technical risks involved with such work and, as a consequence, the contractor shall have no claim against any other party for the loss of equipment, materials or tools incurred in the course of such work.

DB 04.08 **FINAL ACCEPTANCE**

The Hydrogeological Consultant shall accept a successfully finished water supply borehole by issuing of a certificate of completion. At this stage, the Hydrogeological Consultant shall have established that all aspects pertaining to the work and the final product meet, at least, those of the various criteria and requirements set out above which have been imposed.

DB 04.09 **APPOINTMENT OF HYDROGEOLOGICAL CONSULTANT**

The Contractor shall be responsible for appointing a Hydrogeological Consultant for the purposes of this contract. The Hydrogeological Consultant shall be registered with the Department of Water Affairs and Forestry and shall be approved by the Engineer.

The Hydrogeological Consultant shall be responsible for the hydrogeological survey to site the borehole, oversee the drilling of the borehole and pump testing the borehole as well classification of the drinking water for domestic purposes.

DB 05 MEASUREMENT AND PAYMENT

DB.01 **DRILLING OF BOREHOLE** ..... Unit: m

The contractor shall be remunerated for drilling per linear metre of depth at the rate tendered for each relevant drilling diameter employed.

The tendered rate shall include full compensation for all labour, equipment and material required, recording and reporting for the complete drilling of the boreholes in accordance with the specification.

DB.02 **BOREHOLE CASING**

DB.02.01 **Steel Casing** ..... Unit: m

The unit of measurement for steel casing per linear metre thereof supplied, delivered and installed.

The tendered rate shall include full compensation for all labour, materials, transport, recording and reporting and equipment required for the complete installation of the casing.

DB.02.02 **Casing Shoe** ..... Unit: item

Remuneration shall be for each casing shoe supplied and installed.

The tendered rate shall include full compensation for all labour, materials, transport, recording and reporting and equipment required for the complete installation of the casing shoe.

DB.02.03 **uPVC Casing** ..... Unit: m

The unit of measurement for uPVC casing per linear metre thereof supplied, delivered and installed.

The tendered rate shall include full compensation for all labour, materials, transport, recording and reporting and equipment required for the complete installation of the casing.

DB.02.04 **Perforated Casing ....** ..... Unit: m

The unit of measurement for perforated casing per linear metre thereof supplied, delivered and installed.

The tendered rate shall include full compensation for all labour, materials, transport, recording and reporting and equipment required for the complete installation of the casing.

DB.03 **RECOVERY OF STEEL CASING**..... Unit: m

Remuneration for the recovery of steel casing shall be per linear metre thereof salvaged from a borehole.

The tendered rate shall include full compensation for all labour, materials, transport, recording and reporting and equipment required for the recovery of steel casing.

DB.04 **APPOINTMENT OF HYDROGEOLOGICAL CONSULTANT**

(a) Appointment of Hydrogeological Consultant ..... Unit: PC Sum

(b) Charge required by Contractor on subitem (a) above ..... Unit: %

Remuneration for the appointment of a Hydrogeological Consultant for compilation of borehole siting and drilling reports as well as supervision of drilling contractor shall be based on a Prime Cost Sum. The Prime Cost Sum provided under subitem (a) in the Schedule of Quantities will be expended in accordance with Subclause 48(2) of the General Conditions of Contract.

The tendered percentage under subitem (b) will be paid to the Contractor on the value of each payment made to the Hydrogeological Consultant.

TECHNICAL SPECIFICATION

DC: BOREHOLE SITING & DRILLING

CONTENTS

DC 01 SCOPE

This specification covers borehole drilling procedures, casing, backfilling, stabilising, protection and recording and reporting of related activities with the drilling of a borehole. The function of drilling of a borehole shall be supply of raw water to the facility at hand.

DC 02 STANDARD SPECIFICATIONS

DC 02.01 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act, 1993 (Act no 85 of 1993) shall be adhered to.

DC 02.02 MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

DC 02.03 MUNICIPAL REGULATIONS, LAWS AND BY-LAWS

All municipal regulations laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

DC 02.03 DWAF GUIDELINES

Minimum Standards and Guidelines for Groundwater Resource Development for the Community Water Supply and Sanitation Programme issued by the Department of Water Affairs and Forestry shall be adhered to unless otherwise specified.

DC 03 CONTRACTOR'S RESPONSIBILITY AND APPROACH

It is required that the drilling of any borehole be approached with due diligence and care on the part of the appointed drilling contractor. Specifically, it is required that the drilling of each borehole be approached on the premise that it will be successful and, as such, will serve the function of a raw water supply to the facility at hand. Under normal circumstances, the pre-drilling of a small diameter pilot borehole will not be

allowed. Such an approach may only be considered with the approval of the Hydrogeological Consultant who shall be required to fully motivate such an approach to the Implementing Authority.

The Drilling Contractor shall function under the direct supervision of the Hydrogeological Consultant. This by no means implies that the Drilling Contractor is absolved from any responsibility. All drilling activities shall, therefore, be approached through communication and discussion between the Hydrogeological Consultant and the contractor with a view to developing the most suitable and mutually acceptable finished product serving the best interests of the project.

Failure by the contractor to timeously render advice and input where required shall be regarded as a dereliction of duty. This responsibility extends to informing the Hydrogeological Consultant of serious reservations regarding any aspect of the work. The contractor shall also be required to maintain the aesthetic appearance of the site during drilling operations, including keeping the site neat, tidy and free of litter. The contractor shall ensure that safety standards are met and that the work site is kept free, as far as is possible, from vehicular and pedestrian traffic and from interested bystanders and onlookers not involved with the project.

The appointed Drilling Contractor shall carry the final responsibility for the finished water supply borehole and all actions and activities leading up thereto.

DC 04 DRILLING PROCEDURE

DC 04.01 WORKMANSHIP & PERFORMANCE

The standard of workmanship of the Drilling Contractor shall be subject to close scrutiny by the Hydrogeological Consultant. Although it cannot be expected of the contractor to complete a specified number of boreholes in a given time period, it is reasonable to expect that "favourable progress" be made under normal circumstances and drilling conditions. An indication of what might be regarded as "favourable progress" is considered to fall in the range of 50 to 100 m of drilling advancement per day taking into consideration interhole moves and setup time.

Although work-in-progress may be completed, the contractor shall under no circumstances vacate a site before the Hydrogeological Consultant has inspected the completed works and provided written approval that the work executed conforms to the requirements of this specification.

DC 04.02 DRILLING TECHNIQUE

The drilling technique to be employed for the project at hand is that of rotary air percussion drilling employing a down-the-hole (DTH) hammer.

Depending on site-specific circumstances other techniques might be employed including: (1) mud rotary drilling, (2) Odex drilling, (3) dual-tube reverse circulation and (4) cable tool percussion drilling. Instances where another drilling technique might be considered more appropriate and efficient shall be identified by the Hydrogeological Consultant during the project and the Contractor informed accordingly.

DC 04.03 EQUIPMENT AND MATERIAL

The equipment made available by the Drilling Contractor shall be in good working order. Equipment shall be maintained in good condition for the duration of the project.

Routine servicing and preventative maintenance of all equipment required for the drilling procedure and other ancillary equipment shall form the responsibility of Contractor and shall be deemed as included in the tendered rates.

The drilling equipment shall include a full air/foam pumping system. At the start of the project, the gauge diameter of the button drill bits to be employed with the rotary air percussion drilling technique shall conform closely to their manufactured gauge and shall also possess all of their tungsten carbide buttons.

The Hydrogeological Consultant shall discuss with the Drilling Contractor the retirement of a bit due to excessive wear or damage incurred during the course of the project. Further, it is imperative that the equipment be of a suitable size and capacity to deal, on occasion, with: (1) deep boreholes (up to 200 m), (2) larger than average borehole diameters (up to 254 mm), (3) large quantities of groundwater and (4) potentially onerous drilling conditions. Since this capability is provided in large measure by the air compressor, it is considered that a compressor having a capacity of at least 2400 kPa (24 bar) and a volume of at least 750 cfm is appropriate for most water borehole drilling applications and conditions using the rotary air percussion technique. In order to maintain the straightness of a borehole, the Hydrogeological Consultant may insist that the drilling contractor employ at least an overshot sleeve (drill collar) fitted to the pneumatic DTH hammer. Further precautions to ensure this aspect might include the use of a stabiliser rod immediately behind the bit/hammer/overshot combination. All materials to be used on the project should be new and meet project specifications.

Steel casing shall be: (1) of the seam-welded type, (2) round, (3) straight, (4) of uniform wall thickness and (5) have bevelled edges. Second-hand material such as steel casing recovered from an earlier borehole can be used provided that it has been refurbished to an acceptable condition. The Hydrogeological Consultant shall have the right to reject, with motivation, any material (including casing) that is deemed inappropriate, substandard or otherwise unsuitable for the project.

DC 04.03 BOREHOLE CONSTRUCTION

This sections addressed certain basic borehole construction practices which will contribute to final acceptance of the successfully finished product.

DC 04.03.01 DRILLING DIAMETER

Drilling of the water supply borehole shall commence at a diameter, which shall allow for the trouble free insertion of casing. Under normal circumstances, this entails drilling a 203 mm (8") or 216 mm (8½") diameter bore through the weathered overburden and any other potentially unstable near surface material. The bore shall penetrate at least three meters into fresh, more competent material before this horizon can be secured from potential collapse or wash-out by casing it off with nominal 165 mm (6½") or 152 mm (6") diameter steel casing. Thereafter, the bore is continued at 165 mm (or 152 mm) drilling diameter to its completion depth.

The presence of unstable rock formations (which are often also associated with groundwater-bearing horizons) at greater depths in the bore generally account for complications, which shall impact, on the abovementioned approach. The Drilling Contractor shall firstly attempt to penetrate through such horizons in order establish their vertical thickness. Such horizons often possess only a temporary instability and become "cleaned out" as drilling advances. In instances where such horizons remain unstable and severely hamper drilling progress, it will become necessary for the contractor to remove the surface casing and ream (widen) the borehole to a diameter

of at least 203 mm (or 216 mm) to the depth of such unstable horizon. It will then be required to re-insert 165 mm (or 152 mm) nominal diameter casing to this depth and attempt to advance this casing through the unstable horizon.

In exceptional circumstances it may even be necessary to re-drill or ream the borehole to a diameter of 254 mm through unstable overburden material, insert nominal 203 mm (or 216 mm) diameter casing through this horizon and widen the borehole to 203 mm (or 216 mm) diameter below this depth to the unstable zone. Extremely onerous drilling conditions at depth might even warrant the commencement of drilling at a diameter of 305 mm or greater. This approach is often taken when aiming to maximise the exploitation of groundwater from a productive karst aquifer.

Information regarding the dimensions of the more commonly used button drill bits for rotary air percussion drilling is given in Table DC.1 together with casing diameters generally associated with each bit gauge.

Table DC.1. Dimensions of commonly used button drillbit gauge diameters for use with the rotary air percussion drilling method

BIT GAUGE DIAMETER	CASING INSIDE DIAMETER FOR DRILL-THROUGH PURPOSES
127 mm (5 in.)	143 to 146 mm
152 mm (6 in.)	156 to 159 mm
165 mm (6½ in.)	168 to 171 mm
203 mm (8 in.)	207 to 212 mm
216 mm (8½ in.)	
254 mm (10 in.)	257 to 264 mm
305 mm (12 in.)	

NOTE:

1. The bit gauge diameter is also given in the Imperial unit of inches (in.) since this unit is still in common use when referring to this parameter.
2. Casing inside diameter varies according to wall thickness (refer Table DC.2).

The information provided in Table DC.1 shows that each bit gauge passes comfortably through casing with a similar nominal diameter. For example, a 203 mm gauge bit can be used to extend the depth of a borehole already equipped with 207 to 212 mm inside diameter casing without having to reduce to the next smallest drilling diameter. Note also that a borehole drilled to a given diameter is able to accept casing having the next smallest diameter. For example, a 203 mm diameter borehole can be fitted with either 152 mm nominal inside diameter or preferably 165 mm nominal inside diameter steel casing.

In view of the foregoing, it is clear that the minimum final cased diameter of a successful raw water supply (for the extent of the facility at hand) borehole shall seldom be less than 152 mm nominal.

DC 04.03.02 STEEL CASING

Steel casing may either be used in a temporary manner or form a permanent part of the borehole infrastructure. Its temporary use is indicated in instances where, for example, the borehole is unsuccessful or the need for it to remain in place becomes redundant. Under these circumstances it is also referred to as a pre-collar, surface casing, starter casing, outer casing or soil casing generally to be removed (recovered) on completion of drilling. It shall be left in place where the Hydrogeological Consultant is of the opinion that the unsuccessful borehole should be secured to serve a long-term groundwater monitoring purpose. In such instances, additional provision shall be made to protect the borehole against actions, which may compromise this function.

Steel casing shall be: (1) of the seam-welded type, (2) round, (3) straight, (4) of uniform wall thickness and (5) have bevelled edges. Second hand material such as steel casing recovered from an earlier borehole can be used provided that it has been refurbished to an acceptable condition. The Hydrogeological Consultant shall have the right to reject, with motivation, any material (including casing) that is deemed inappropriate, substandard or otherwise unsuitable for the project.

More commonly, however, this casing constitutes the final casing with which a successful borehole is equipped. Its proper installation, therefore, is mandatory. It is installed from surface through unstable, unconsolidated or fractured materials usually occurring in the near surface. Under these circumstances, the function of steel casing includes one or more of: (1) supporting unstable materials against collapse into the borehole during drilling, (2) facilitating the installation or removal of other casing, (3) minimising the erosion and widening of the unstable upper portions of the borehole sidewall caused by the return flow established during drilling and/or the passage of drilling equipment/tools and (4) facilitating the placement of a sanitary seal and/or gravel pack or formation stabiliser.

In order to ensure as far as is possible that the annular space between this casing and the borehole sidewall remains open for the later emplacement of a sanitary seal, the circumferential entrance to this space shall be temporarily plugged. Hessian sacking packed around and lightly tamped into the surface entrance to this annular space can be used for this purpose. In instances where steel casing needs to be driven through unstable horizons (generally at greater depths in a borehole), it will be also be required that such casing be fitted with a casing shoe to protect the "mouth" of the casing from damage. Irrespective of the casing used to facilitate the drilling of the borehole, the final cased diameter of the finished product shall be sufficient for the borehole to easily accept a borehole pump. Since the outside diameter of the latter are generally in the order of 100 mm, it is required that the final cased diameter of the borehole not be less than 152 mm (6 in.) nominal where steel casing is used. Information on the dimensions of the more commonly used steel casing available locally is given in Table DC.2.

Table DC.2. Dimensions of commonly used and locally available steel borehole casing

OUTSIDE DIAMETER	WALL THICKNESS	INSIDE DIAMETER
165 mm (6 in. nominal)	3.0 mm 4.0 mm 4.5 mm	159 mm 157 mm 156 mm
177 mm (6½ in. nominal)	3.0 mm 4.0 mm 4.5 mm	171 mm 169 mm 168 mm
219 mm (8 in. nominal)	3.5 mm 4.5 mm 6.0 mm	212 mm 210 mm 207 mm
273 mm (10 in. nominal)	4.5 mm 6.0 mm 8.0 mm	264 mm 261 mm 257 mm

NOTES:
1. The casing outside diameter dimensions are also given in the Imperial unit of inches (in.) since this unit is still in common use when referring to this parameter.
2. Use of the term "nominal" when referring to casing diameter provides a direct association with the gauge of the bit (Table DC.1) which most closely passes through it.

DC 04.03.03 **CASING SHOE**

This item is fitted (welded) to the bottom end (foot) of a casing string in order to protect the "mouth" of the casing from damage due to forcing the casing through unstable horizons. Its use is therefore only warranted (indeed mandatory) in instances where such conditions reveal themselves to require securement through the emplacement of casing.

DC 04.03.04 **uPVC CASING**

Also referred to as thermoplastic casing, the material generally comprises PVC (polyvinyl chloride) which, when treated to withstand ultraviolet radiation, is known as uPVC casing. Its application in the construction of water supply boreholes is specific, being used mainly in instances where security against the collapse of a borehole sidewall is required and where steel casing does not already offer such security. In such instances, the casing is inserted the entire length of the borehole and will certainly be perforated for some portion of its length.

The diameter of this casing will also necessarily be smaller than that of the steel casing used which, in most instances, will have a nominal diameter of 165 mm. In order not to compromise too severely on the minimum nominal diameter requirement of 152 mm for successfully completed water supply boreholes, the inside diameter of the uPVC casing shall not be less than 128 mm with a wall thickness of 6 mm. It is also common practice to leave the steel casing in place in order to provide protection for the uPVC casing. The decision to use uPVC casing in the final construction of a borehole shall be made by the Hydrogeological Consultant.

DC 04.03.05 PERFORATED CASING

For the purposes of this project, perforated casing used shall be of a prefabricated type. As a general guideline, slots should be: (1) 300 mm in length, (2) 3 to 4 mm wide, (3) positioned in bands around the circumference of the casing, (4) spaced equally in each band, (5) each circumferential band of slots separated by 100 mm of plain pipe, (6) every second band of slots aligned with one another and (7) a 300 mm section of plain pipe left at both ends of the casing.

Bearing in mind that the number of slots forming each circumferential band depends not only on the casing diameter but also impact on the strength of the casing, it is suggested that the guidelines presented in Table DC.3 be adhered to in this regard.

Table DC.3. Recommended number of slots per circumferential band for various steel casing diameters and associated percentage open area provided

NOMINAL CASING DIAMETER	NUMBER OF SLOTS PER CIRCUMFERENTIAL BAND	PERCENTAGE OPEN AREA
152 mm	6	3.0%
165 mm	8	3.7%
203 mm	10	3.7%

Also presented in this table (Table DC.3) is the approximate open area provided by the above slot pattern applied to each of the given casing diameters. In certain instances, however, it may be required to use more sophisticated and expensive slotted casing. Also known as screens, these include: (1) continuously wound wedge wire screens, (2) louvered screens or bridge-slotted screens and (3) screens pre-coated with gravel. The decision to use such screens shall again be made by the Hydrogeological Consultant after providing motivation to and gaining acceptance from the Implementing Authority.

DC 04.03.06 RECOVERY OF STEEL CASING

The contractor shall make every effort to recover, only on instruction from the Hydrogeological Consultant, steel casing from unsuccessful or abandoned boreholes. This casing can also be refurbished to an acceptable condition for re-use.

DC 04.03.07 BOREHOLE STRAIGHTNESS

The Drilling Contractor in the presence of the Hydrogeological Consultant shall perform the straightness test and its success (or failure) recorded by this party.

A borehole, which fails a straightness test, shall be deemed lost and it shall be required of the Drilling Contractor to drill a replacement borehole at own expense. In the event that a straightness test is made before completion of the borehole, then the contractor shall be required to cease operations and facilitate access to the borehole for the duration of such activity.

DC 04.03.08 **BOREHOLE VERTICALITY**

The Hydrogeological Consultant in the presence of the Drilling Contractor shall perform the verticality test. The consultant shall therefore be required to provide the necessary equipment for conducting a verticality test. A borehole, which fails a verticality test, shall be deemed lost and it shall be required of the contractor to drill a replacement borehole at own expense. In the event that a verticality test is made before completion of the borehole, then the Drilling Contractor shall be required to cease operations and facilitate access to the borehole for the duration of such activity.

DC 04.03.09 **BACKFILLING**

This entails filling the annular space between the borehole sidewall and the outside of the casing with suitable material. The purpose of annular backfilling includes: (1) the provision of a base on which to found a sanitary seal and (2) the provision of support for the sidewalls of the borehole and the casing. In instances where casing has been seated at a comparatively shallow depth in fresh material below a weathered near-surface horizon, all of the drill cuttings removed from the borehole whilst drilling represents suitable material for this purpose. Annular backfilling with this material is not advisable in instances where this is not the case, such as for example where the casing extends to a substantial depth and comprises slotted/perforated sections or where the water-bearing horizon is shallow and open to the borehole via slotted/perforated casing. In these instances, it shall be required to insert a formation stabiliser into the annulus. The backfilling shall extend to within approximately 5 m of the ground surface.

The Contractor shall allow for the cost of backfilling in the tendered rates.

DC 04.03.10 **FORMATION STABILISER**

This comprises material, which is placed in the annulus between the borehole sidewall and perforated/slotted sections of casing to stabilise the formation against collapse and ingress into the borehole. The drill cuttings and spoils removed from the borehole is not suitable material for this purpose. The stabiliser shall comprise material which is: (1) well sorted, (2) well rounded, (3) low in calcareous content and (4) graded such that the smallest grain size is larger than the casing perforations/slots. The stabiliser material can either be placed by hand or through a tremie pipe. Excessive bridging of stabiliser material in the annulus can be prevented: (1) through the use of centralisers on the casing or (2) by washing it in with clean water. The formation stabiliser should extend some 10 m above the top of the uppermost perforated/slotted section of casing before the borehole is developed.

The Contractor shall allow for the cost of formation stabilising in the tendered rates.

DC 04.03.11 **CONCRETE COLLAR**

The Drilling Contractor shall construct a shallow circular concrete collar around each successfully completed borehole. This collar shall have dimensions and volume as specified by the Hydrogeological Consultant. The concrete mixture shall required strength of some 30 MPa after 28 days. A similar collar may need to be constructed, on request of the Hydrogeological Consultant, over unsuccessful or abandoned boreholes.

The Contractor shall allow for the cost of the concrete collar in the tendered rates.

DC 04.03.12 **UNSUCCESSFUL AND ABANDONED BOREHOLES**

A borehole shall be declared unsuccessful at the discretion of the Hydrogeological Consultant. The latter may also, at any time during the course of the work, order the abandonment of a borehole in progress.

In such instances, the Hydrogeological Consultant shall instruct the Drilling Contractor on further actions to be taken. These may include either: (1) the salvage of any casing from the borehole and (2) the plugging of the borehole or (3) the securement of the borehole for long term monitoring purposes, in which it case it shall be provided with a sanitary seal concrete collar protection and marking.

Plugging (or finishing) of an unsuccessful or abandoned borehole is aimed at removing any danger or hazard such boreholes may present to the environment, eg. as a conduit for the inflow of surface water into the groundwater regime or as a danger to traffic (whether human, stock or vehicular) in the immediate vicinity thereof. It shall also be required to cast a concrete collar over the infilled borehole.

The Drilling Contractor shall be remunerated for an unsuccessful or abandoned borehole on the basis of tendered rates in the Schedule of Rates for such of the following items as are relevant: (1) drilling per linear metre of depth for each relevant drilling diameter employed, (2) steel casing per linear metre thereof recovered, (3) backfilling, (4) a sanitary seal, (5) borehole protection and (6) borehole marking. Payment for any casing left behind in an unsuccessful or abandoned borehole will only be made, on the same basis as described in (2) above, on written certification by the Hydrogeological Consultant that the contractor has made every reasonable attempt in this regard.

DC 04.03.13 **LOST BOREHOLES**

A borehole shall be declared lost by the Hydrogeological Consultant in the event that it can not be completed satisfactorily due to factors such as: (1) the irrecoverable loss of drilling equipment, materials or tools therein, (2) accident to plant or heavy machinery, (3) failure to pass a straightness test and (4) failure to pass a verticality test. A decision in this regard shall be made after consultation with the Drilling Contractor, who shall have the considered option to either attempt remediation of the situation to the satisfaction of the Hydrogeological Consultant or, alternatively, declare the situation irretrievable. No payment shall be made for any work done, materials used or time spent by the Drilling Contractor on a lost borehole. The cost of any materials recovered in a damaged state from a lost borehole shall be borne by the contractor.

A borehole, which is declared lost, shall be replaced with a new borehole to be constructed by the Drilling Contractor in the vicinity of the lost borehole and at a position indicated by the Hydrogeological Consultant. Payment for a new borehole constructed under these circumstances shall be made on the same basis as for any other successfully completed borehole. Materials recovered in good condition may, however, be re-used by the contractor.

DC 04.03.14 **SANITARY SEAL**

Every successful water supply borehole shall be provided with a sanitary seal. The seal shall consist of portland cement mixed to slurry with bentonite and water, which is free of oil and other organic matter. The bentonite and water should be thoroughly mixed in the ratio of 2 kg bentonite to 25 l water prior to adding and mixing in 50 kg (one bag) cement. The final grout seal shall extend to a depth of at least 5 m below ground surface, ie. founded on the backfilling. In such shallow applications, the slurry

can be gravity-fed into the annulus through a small diameter tube (tremie pipe) extending to the depth of emplacement. The tremie pipe should be withdrawn slowly as the slurry fills up the annulus. There shall be no voids in the sanitary seal.

The Contractor shall allow for the cost of the sanitary seal in the tendered rates.

DC 04.03.15 BOREHOLE DEVELOPMENT

The Geo-hydrologist shall submit proof of sufficient borehole development procedures. This activity shall be concluded with the collection of a 1liter representative water sample obtained from the return flow during development.

The Contractor shall allow for the cost of borehole development in the tendered rates.

DC 04.03.16 BOREHOLE DISINFECTION

The Geo-hydrologist shall submit proof of sufficient borehole disinfection procedures.

Guideline volumes/weights of common compounds to be used for disinfection purposes under most normal circumstances can be derived from the information provided in Table DC.4.

The Contractor shall allow for the cost of borehole disinfection in the tendered rates.

Table DC.4. Guideline volumes/weights of common sterilants to be used per unit volume of water for various borehole diameters

	VOLUME OF WATER PER METRE OF BOREHOLE	VOLUME/WEIGHT OF STERILANT TO BE USED FOR DISINFECTION PER UNIT VOLUME OF WATER BELOW GROUNDWATER REST LEVEL		
		Sodium hypochlorite	Calcium	Chlorinated lime
	18 l	500 ml (2 cups)	26 g (¼ cup)	90 g (1 cup)
	21 l	600 ml (2½ cups)	30 g (_ cup)	105 g (1 cup)
	33 l	940 ml (4 cups)	47 g (½ cup)	165 g (1½ cups)
	51 l	1500 ml (6 cups)	73 g (¾ cup)	255 g (2½ cups)

NOTES:

1. No distinction is drawn between open and cased portions of a borehole since these differences are considered to have a negligible impact on calculated unit volumes.
2. The trade percentage of chlorine in the listed sterilises is taken to be:
   3.5 percent by volume (35 ml/l) for sodium hypochlorite,
   70 percent by weight (700 g/kg) for calcium hypochlorite,
   and 20 percent by weight (200 g/kg) for chlorinated lime.

EXAMPLE:
A 100-metre deep borehole with a nominal diameter of 165 mm and with a rest water level standing at a depth of 25 m below surface will require 75 x 30 g = 2,250 g (2.25 kg), alternatively 75 x _ cup = 25 cups, of calcium hypochlorite to achieve adequate disinfection. The same situation would require 75 x 600 ml = 45,000 ml (45 l) of sodium hypochlorite to achieve adequate disinfection.

DC 04.03.17 BOREHOLE PROTECTION

This entails sealing the borehole from the introduction of foreign material directly through the casing.

In order to provide the Hydrogeological Consultant with ready access to the borehole for water level measuring purposes, it is required that a small hole be drilled in the lid. This hole shall be furnished with a tamper-proof plug such as a "dead-end" threaded into a water pipe connector welded on the hole. The final diameter of the hole providing access to the borehole shall be sufficient to allow a "normal" dip meter probe to pass through it. It is considered that a diameter of at least 10 mm and not more than 20 mm is suitable for this purpose.

The Contractor shall allow for the cost of borehole protection in the tendered rates.

DC 04.03.18 BOREHOLE MARKING (IN THE FIELD)

The activity itself represents marking the borehole by: (1) script-welding its assigned and unique identifying number onto the lid of the borehole and (2) planting a concrete block with dimensions of 200 mm x 200 mm x 200 mm (also bearing the number of the borehole) in the ground a distance of five metres to the north of the borehole.

It is the responsibility of the Hydrogeological Consultant to ensure that a borehole number is provided to the contractor for this purpose.

The Contractor shall allow for the cost of borehole marking in the tendered rates.

DC 04.03.19 SITE FINISHING

The activities associated with this task shall include the repair of construction scars on the work site resulting from drilling activities as well as the general cleanup of the site of waste materials, debris and oil spills. The latter shall be shoveled over and worked into the ground wherever possible.

Site finishing shall be deemed as included in the tendered rates.

DC 04.04 DATA RECORDING AND REPORTING

A detailed and accurate record of all information arising from the borehole drilling activity shall be recorded with care and diligence. The Drilling Contractor can collect much of this information. The Hydrogeological Consultant shall keep this current and available for inspection on request.

The contractor shall include the cost of data recording and reporting in the tendered rates.

It shall be the responsibility of the Hydrogeological Consultant to verify receipt of this information prior to certifying a claim by the Drilling Contractor in this regard. The following items of information represent the minimum number of parameters, which shall be monitored and recorded by the contractor:

Penetration Rate
Formation Sampling and Description
Water Strike Depth
Blow Yield
Groundwater Rest Level

DC 04.05 **DOWN-THE-HOLE LOSS OF EQUIPMENT**

The Hydrogeological Consultant shall afford the contractor every opportunity and reasonable time to fish for lost equipment. The Drilling Contractor shall, in turn, keep the Hydrogeological Consultant informed of progress and the likelihood of success in this regard. The contractor shall have no claim against any other party for any losses incurred in this regard. The Hydrogeological Consultant shall finally decide on the fate of the borehole. It may either be declared successful or lost.

DC 04.05.01 **BOREHOLE DECLARED SUCCESSFUL**

Circumstances under which a borehole may be declared successful include: (1) the borehole has encountered significant water, (2) pumping equipment can be installed to an acceptable depth in the borehole and (3) the lost equipment does not pose a threat to the present and future quality of the groundwater. In the event that a borehole is declared successful despite the irrecoverable loss of drilling equipment, materials or tools therein, then the exact nature and position of the equipment lost in the borehole shall be recorded and appear in relevant project documentation. The Drilling Contractor shall be remunerated for a borehole declared successful under these circumstances on the same basis as for any other successfully completed borehole.

DC 04.05.02 **BOREHOLE DECLARED LOST**

Refer to paragraph DC 04.03.13.

DC 04.06 **BOREHOLE INFORMATION REQUIRED**

A detailed and accurate record of all information arising from the following activities shall be submitted by the Hydrogeological Consultant.
Down-the-hole borehole measurement
Borehole Construction Information
Geological Information
Hydrogeological Information
Hydro chemical Information

The Contractor shall allow for the cost of the information in the tendered rates.

DC 04.07 **REHABILITATION OF EXISTING BOREHOLES**

The scope of this work may vary from the basic cleaning out and re-development of an existing borehole to the recovery of casing, the reaming and subsequent re-installation of casing. The nature of the rehabilitation required in each individual instance shall be identified prior to undertaking this activity since this shall indicate which equipment will most suitably complete the task.

The rehabilitation of an existing borehole shall be carried out under the supervision of the Hydrogeological Consultant. In any event, the execution of such work shall be subject to the same degree of data collection and record keeping as is required of a new borehole.

The Drilling Contractor shall be remunerated for this service on the basis of the rates tendered as per section DC 05. It shall be expected of the contractor to have assessed the potential technical risks involved with such work and, as a consequence, the contractor shall have no claim against any other party for the loss of equipment, materials or tools incurred in the course of such work.

DC 04.08 **FINAL ACCEPTANCE**

The Hydrogeological Consultant shall accept a successfully finished water supply borehole by issuing of a certificate of completion. At this stage, the Hydrogeological Consultant shall have established that all aspects pertaining to the work and the final product meet, at least, those of the various criteria and requirements set out above which have been imposed.

DC 04.09 **APPOINTMENT OF HYDROGEOLOGICAL CONSULTANT**

The Contractor shall be responsible for appointing a Hydrogeological Consultant for the purposes of this contract. The Hydrogeological Consultant shall be registered with the Department of Water Affairs and Forestry and shall be approved by the Engineer.

The Hydrogeological Consultant shall be responsible for the hydrogeological survey to site the borehole, oversee the drilling of the borehole and pump testing the borehole as well classification of the drinking water for domestic purposes.

DC 05 MEASUREMENT AND PAYMENT

DC.05.01 **DRILLING OF BOREHOLE** ..... Unit: m

The contractor shall be remunerated for drilling per linear metre of depth at the rate tendered for each relevant drilling diameter employed.

The tendered rate shall include full compensation for all labour, equipment and material required, recording and reporting for the complete drilling of the boreholes in accordance with the specification.

DC.05.02 **BOREHOLE CASING**

DC.05.02.01 **Steel Casing** ..... Unit: m

The unit of measurement for steel casing per linear metre thereof supplied, delivered and installed.

The tendered rate shall include full compensation for all labour, materials, transport, recording and reporting and equipment required for the complete installation of the casing.

DC.05.02.02 **Casing Shoe** ..... Unit: item

Remuneration shall be for each casing shoe supplied and installed.

The tendered rate shall include full compensation for all labour, materials, transport, recording and reporting and equipment required for the complete installation of the casing shoe.

DC.05.02.03 **uPVC Casing** .... Unit: m

The unit of measurement for uPVC casing per linear metre thereof supplied, delivered and installed.

The tendered rate shall include full compensation for all labour, materials, transport, recording and reporting and equipment required for the complete installation of the casing.

DC.05.02.04 **Perforated Casing ....** ..... Unit: m

The unit of measurement for perforated casing per linear metre thereof supplied, delivered and installed.

The tendered rate shall include full compensation for all labour, materials, transport, recording and reporting and equipment required for the complete installation of the casing.

DC.05.03 **RECOVERY OF STEEL CASING** ..... Unit: m

Remuneration for the recovery of steel casing shall be per linear metre thereof salvaged from a borehole.

The tendered rate shall include full compensation for all labour, materials, transport, recording and reporting and equipment required for the recovery of steel casing.

DC.05.04 **APPOINTMENT OF HYDROGEOLOGICAL CONSULTANT**

(a) Appointment of Hydrogeological Consultant ..... Unit: PC Sum

(b) Charge required by Contractor on subitem (a) above ..... Unit: %

Remuneration for the appointment of a Hydrogeological Consultant shall be based on a Prime Cost Sum. The Prime Cost Sum provided under subitem (a) in the Schedule of Quantities will be expended in accordance with Subclause 48(2) of the General Conditions of Contract.

The tendered percentage under subitem (b) will be paid to the Contractor on the value of each payment made to the Hydrogeological Consultant.

DC.05.05 **REHABILITATION OF EXISTING BOREHOLES** ..... Unit: m

The contractor shall be remunerated for rehabilitation of an existing borehole by by means of drilling per linear metre of depth at the rate tendered for each relevant drilling diameter employed.

The contractor shall also be remunerated for the basic cleaning out and re-development of an existing borehole to the recovery of casing, the reaming and subsequent re-installation of casing. The nature of the rehabilitation required in each individual instance shall be identified prior to undertaking this activity since this shall indicate which equipment will most suitably complete the task.

The tendered rate shall include full compensation for all labour, equipment and material required recording and reporting for the complete drilling of the boreholes in order to rehabilitate an existing borehole in accordance with the specification.

The rehabilitation of an existing borehole shall be carried out under the supervision of the Hydrogeological Consultant. In any event, the execution of such work shall be subject to the same degree of data collection and record keeping as is required of a new borehole.

It shall be expected of the contractor to have assessed the potential technical risks involved with such work and, as a consequence, the contractor shall have no claim against any other party for the loss of equipment, materials or tools incurred in the course of such work.

TECHNICAL SPECIFICATION

DF: POTABLE WATER DISINFECTION AND SEDIMENTATION UNITS

CONTENTS

DF 01 SCOPE

This section covers the repair and maintenance of the equipment used to add chemicals as part of the treatment of the potable water at the water treatment works at Beit Bridge . The dosing equipment used to add flocculent to the raw water and the dosing equipment used to chlorinate treated water before its pumped to the pressure tower are covered.

All additives (chemicals) to be added to raw water and treated water as part of the water treatment process *shall be supplied by* ***others***. It shall ***not*** be the responsibility of the Contractor to supply, store, manage or add chemicals as part of the operation of the water treatment works whatsoever.

The Contractor shall be responsible for repair and maintenance of the equipment as specified. ***Operating of the water treatment works is performed by Department of Public Works' staff. Operating of the water treatment works does not form part of this contract.*** The Contractor shall be responsible for training of the departmental staff in the operating of the water treatment works (based on the operating and maintenance manuals), as specified elsewhere.

DF 02 STANDARDS AND REQUIREMENTS

DF 02.01 STANDARD SPECIFICATIONS

These specifications shall be read in conjunction with the following documents:

SABS 241:	Water for domestic supplies
SABS 295:	Calcium Hypochlorate

DF 02.02 MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS

All equipment and materials shall be installed, serviced and repaired strictly in accordance with manufacturers specifications, instructions and codes of practice.

DF 02.03 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health And Safety Act Of 1993 shall be adhered to.

DF 03 DETAIL OF WORK

The dosing equipment used to add flocculent to the raw water and the dosing equipment used to chlorinate treated water, before water is pumped to the pressure tower are all in a perfect working order at the time of this tender.

The Contractor shall be granted the opportunity to remove, service and reinstall the equipment as per the work measured in the schedule of quantities for repair work. Subsequent to the completion of the repair work as measured, the Contractor shall be responsible for the maintenance of the dosing equipment.

DF 04 SERVICING OF EQUIPMENT

The Contractor shall service the dosing equipment according to the specification that shall be provided in the Operating and Maintenance Manuals to be developed as part of this contract.

The Contractor shall set equipment to comply with the dosing rate as follows:

The average flow rate of the raw water through the flocculation installation and of treated water through the chlorination installation shall be determined as accurate as possible

Dosing rates shall be determined from the manufacturers of the dosing equipment and compared with that of the chemical suppliers (To be reflected in Operating and Maintenance manuals) after which the equipment shall be adjusted and tested to comply with the specification rates

The actions and procedures for setting of dosing equipment rates shall be reflected in the Operating and Maintenance manuals.

DF 05 MAINTENANCE

The dosing equipment used to add flocculent to the raw water and the dosing equipment used to chlorinate treated water, before water is pumped to the pressure tower shall be maintained by the Contractor as soon as the repair work measured in the schedule of quantities has been completed.

Maintenance shall include all repair work, replacing of components, fixing leaks, routine settings (of dosing rates etc.), corrosion protection and all other actions necessary to maintain dosing equipment in a perfect functional condition.

Remuneration for maintenance of dosing equipment shall be deemed included in the tendered monthly rate, based on the point system, for the maintenance of installation G.

DF 06 MEASUREMENT AND PAYMENT

Item

DF.06.01 **DECOMMISSIONING AND REMOVAL OF DOSING EQUIPMENT** ... **Unit**: number

The unit of measurement shall be the number of dosing equipment units decommissioned and removed.

The tendered rates shall include full compensation for the removal, storage, safe keeping and all other actions required to be able to service the equipment. Separate items will be listed in the schedule of quantities for different sizes of equipment.

DF.06.02 **SERVICE DOSING EQUIPMENT** ..... **Unit**: number

The unit of measurement shall be the number of dosing equipment units serviced.

The tendered rate shall include full compensation for cleaning, removing rust, removing dried sludge or other solids from surfaces and moving parts, proper greasing of all moving parts, preparation for corrosion protection (where applicable) coating (where applicable) and painting (where applicable) of dosing equipment units with its appurtenant material, and all other servicing actions as specified by the supplier. After servicing, the dosing equipment shall be in a perfect working order, adding additives at rates as specified in Operating and Maintenance manuals.

Separate items will be listed in the schedule of quantities for different types and sizes of equipment.

DF.06.03 **INSTALLATION, TESTING AND COMMISSIONING OF DOSING EQUIPMENT** **Unit**: number

The unit of measurement shall be the number of dosing equipment units installed, commissioned and tested.

The tendered rates shall include full compensation for the installation and commissioning of the dosing equipment, to render the installation in a perfect working order, adding additives at rates as specified in the operating and maintenance manuals.

Separate items will be listed in the schedule of quantities for different sizes of equipment.

DF.06.04 **SUPPLY, DELIVERY, INSTALLATION, TESTING AND COMMISSIONING OF DOSING EQUIPMENT** **Unit**: number

The unit of measurement shall be the number of dosing equipment units installed, commissioned and tested.

The tendered rates shall include full compensation for the supply, delivery, installation and commissioning of the dosing equipment, to render the installation in a perfect working order, adding additives at rates as specified in the operating and maintenance manuals.

Separate items will be listed in the schedule of quantities for different sizes of equipment.

TECHNICAL SPECIFICATION

DH: OPERATION OF POTABLE WATER WORKS

CONTENTS

DH 01 SCOPE

Potable water works shall mean all units, components, equipment and materials, and their relation to each other, employed to enable reliable and effective water treatment.

This specification covers the operation of a bulk water supply system with borehole pump systems and equipment related to effective water treatment.

The Contractor shall manage and operate the water supply system in accordance with the prescriptions in this specification, the relevant operation and maintenance manuals and **Additional Specification SF**. Operation duties shall generally refer to all tasks and actions required for operating the process units and components of the water works typically found at remote DPW sites such as police stations, border posts, etc. These works shall include (among others):

1. **Local authority connection with on-site storage**
   - Water meter and isolating valves at connection.
   - Feed to ground level and/or elevated tank(s).
     - Ground level tank/reservoir.
   - Pump and rising main from ground level tank to elevated tank.
     - Chlorination unit.
   - Feed from elevated reservoir to first user connection.

2. **Borehole(s):**
   - Two fully equipped production borehole(s): Duty (at least) and stand-by (where available).
   - Monitoring borehole (where applicable).
   - Water meter and isolating valves at each production borehole.
   - Feed to ground level and/or elevated tank(s).
     - Ground level tank/reservoir.
   - Pump and rising main from boreholes to ground level tank/reservoir.
     - Chlorination unit.
   - Feed from elevated reservoir to first user connection.

3. **River abstraction and conventional surface water treatment:**
   Abstraction well.
   Borehole pumps and rising main to raw water storage tank (ground level tank).
   Raw water storage tank.
   Gravity/pump feed to treatment unit.
   Treatment unit: chemical dosing, clarifiers, pressure filters, transfer pumps and chlorination.
   Feed to ground level and/or elevated tank(s). Ground level tank/reservoir.
   Pump and rising main from ground level tank to elevated tank.
   Feed from elevated reservoir to first user connection.

This specification covers requirements for potable water quality, as well as testing procedures and equipment to verify these requirements.

This specification shall form an integral part of the repair and maintenance contract document and shall be read in conjunction with Portion 3: Additional Specifications included in this document.

DH 02 STANDARD SPECIFICATIONS AND REGULATIONS

DH 02.01 GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES

The latest edition, including all amendments up to date of tender, of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof.

SANS 1200	-	Standardised specification for civil engineering construction
SANS 5667-2	-	Water quality sampling, part 2: Guidance on sampling techniques
SANS 241	-	South African Standard Specification for drinking water

DH 02.02 OTHER SPECIFICATIONS

The following Technical Specifications for repair and maintenance of water process units shall be read in conjunction with this specification and shall be deemed to form part thereof:

CI Pressed steel tanks
CE Water Distribution Networks
DA Borehole pump systems
DB Potable Water Filtration Systems
DF Potable Water Disinfection and Filtration Units
SF General Operation

DH 02.03 ACTS, REGULATIONS AND STATUTORY REQUIREMENTS

All relevant regulations and statutory requirements as laid down in the latest edition of the following acts shall be adhered to:

- Occupational Health and Safety Act, 1993 (No. 85 of 1993)
- National Water Act (No. 36 of 1998)
- Water Services Act (No. 108 of 1997)

- Environment Conservation Act (No. 73 of 1989)
- National Environmental Management Act (No. 107 of 1998)

DH 02.04 MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

DH 02.05 MUNICIPAL REGULATIONS, LAWS AND BY-LAWS

All municipal regulations, laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

DH 03 LEGAL AND GENERAL REQUIREMENTS

DH 03.01 DEFINITION OF WATER USE

This specification covers the legal requirements for water use as regulated by the National Water Act (No. 36 of 1998). A large fraction of the activities performed by the Department of Public Works is covered by the general authorisations in terms of Section 39 of the Water Act. The following categories of water use are scheduled:

Taking of water and storage of water (Section 2 (a) and (b)) of the Water Act.

Engaging in a controlled activity, identified as such in Section 37 (1) of the Water Act. Irrigation of any land with waste or water containing waste generated through any industrial activity or by a water works (Section 21 (e) of the Water Act).

Discharging of waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit, and disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generating process.

Disposing of waste in a manner which may detrimentally impact a water resource (Section 28 of the Water Act).

DH 03.02 REGISTRATION OF WATER USE

According to the Water Act water use must be registered with the Department of Water and Sanitation (DWS). The prescribed forms are available on DWAF's internet web site:

http://www.dwaf.gov.za

The application forms for registration or licensing of a water use are available on the above website. Forms DW 771 / DW 758 R1c.doc (updated version) – Licensing Part 1: Company, Business or Partnership, National or Provincial Government are applicable.

Parts 1, 3, 4 and 8 of these forms will be completed by the Department of Public Works. All other forms shall be completed and submitted by the Contractor.

These registration forms shall be completed by the Contractor and must be submitted to:

The Director-General
Department of Public Works
Private Bag X65
PRETORIA
2001

For attention of: **Director, Town Planning**

Based on the information so provided, the Department of Water Affairs and Forestry may require the applicant to apply for a license for the relevant water or wastewater use.

DH 03.03 **LICENSING OF A WATER USE**

In general a water use must be licensed unless it is:

Listed in Schedule 1 (See page 152 of Government Gazette No. 19182 dated 26 August 1998)

An existing lawful use.

Permissible under a general authorisation (See Government Gazette No. 20526 dated 8 October 1999)

The responsible authority can waive the need for a license.

If licensing is required, the Department of Public Works will appoint an independent consultant for the duty.

DH 03.04 **OPERATOR REGISTRATION AND CLASSIFICATION OF WATER CARE WORKS**

In the terms of Section 26 (f) of the Water Act (No. 36 of 1988) operators shall be registered with the Department of Water Affairs and Forestry. The Contractor shall be responsible for the registration of workers/operators in terms of this requirement (See Regulation R2834 dated 27 December 1985).

For tendering purposes, the Beit Bridge Port of Entry Water Treatment Works is classified as a Class D works. The minimum Class of process controller for a Class D Works is a Class II operator and supervision shall be done by a Class V operator.

In addition to the operating staff, operations and maintenance support services shall include electrical, mechanical and instrumentation personnel.

DH 03.05 **ENVIRONMENTAL IMPACT ASSESSMENT (EIA)**

In terms of Government Notices R1182 and R1183 of 5 September 1997, new water care works as well as upgrading of water care works are generally subject to Environmental Impact Assessment. The relevant procedures are described in a guideline document: EIA Regulations, Implementation of Sections 21, 22 and 26 of the Environment Conservation Act (No. 73 of 1989).

An independent consultant will generally be appointed to conduct such assessment. An EIA must be submitted to the Department of Environmental Affairs and Tourism for approval by means of a Record of Decision.

Under normal conditions, an EIA will not be required for repair of water care works.

DH 03.06 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

An Environmental Management Plan (EMP) is required for all repair work that may generate waste (such as water treatment sludge) or that may detrimentally impact the environment during repair and operation of the water care works.

The Contractor shall prepare and submit an EMP to the Department of Public Works' project manager. His approval is not required, but the EMP should guide repair work so as to safeguard the environment from detrimental impact. The Contractor shall make provision in his tendered rates for all costs implied by the EMP.

DH 04 DETAILS OF THE REPAIR WORK

The following repair works shall be performed at the works:

(a) Repair control system of pumps to prevent wastage of water when reservoirs are full.
(b) Re-align and set level controls in reservoirs and tanks.
(c) Provide adequate lighting in the clarification area covered by sheeting to meet OHS requirements.
(d) Fix erosion at overflows of reservoirs and tanks.
(e) Repair concrete at reservoirs and tanks.
(f) Repair and repaint all rusted metal at Motor Control Centres (MCC).
(g) Clean clarifiers.
(h) Remove and relay telephone wires at reservoir and filtration building.
(i) Repair all cable rays and guides.
(j) Replace all pipes and valves in high elevation tank.
(k) Replace stairs and ladders in the high elevation tank.
(l) Repair concrete at high elevation tank.

At the time of the inspection, the control of the pumps was not acceptable, as the reservoirs were overflowing and the pumps still attempted to start. This situation needs to be rectified and kept in operation to prevent damage to the equipment and wastage of the scarce water. All erosion shall be fixed under Specification CA: Roads and Storm water.

The area of the clarifiers covered with sheeting does not conform to OHS requirements, and adequate lighting shall be provided by the Contractor. He shall be responsible for the design of the system to the approval of the Engineer.

The concrete structures show signs of chipping in various locations, and in some instances the reinforcing is exposed. These areas have to be repaired in accordance with the requirements of the suppliers of concrete repair kits (SIKA or approved similar). This work shall be performed and measured under Specification BK Structural Concrete.

All MCCs need to be serviced and corrective maintenance being applied in respect of the rusting of elements of the installations. This also includes all cable racks and cables trays that are damaged and rusted.

The condition of the steel works in the elevated storage tank is becoming an OHS risk and needs to be replaced. The contractor shall be responsible to demolish all steel works that cannot be safely reconditioned and re-used for stairs and ladders. All treads of the stairs and ladders shall be replaced. The contractor shall be responsible for the design, manufacture and delivery to site, installation and commissioning. The works shall be executed under Specification BK: Metal Works.

Similarly, the contractor shall replace of repair, as the case may be, the pipe work and valves in the elevated tower in collaboration with the engineer.

The contractor shall provide a methodology on how the works shall be performed allowing minimal disruption of the water supply to the users of the water.

The concrete of the elevated tower shall be repaired to prevent long-term damage and a deterioration there-of. The Contractor shall design a methodology on how the work shall be performed in conjunction with the Engineer to ensure the most economical repairs with the least disruption of the service. The contractor could be required a pumping system that will t maintain the water pressure so that all facilities receive an acceptable level of service in respect of water supply.

DH 05 OPERATION

DH 05.01 GENERAL

Operation shall include all activities and all other actions or rectifying measures necessary for optimal operation of water care works.

Remuneration for operation of the complete water works shall be deemed included in at the tendered rate for monthly payment of operation of the works.

The Beitbridge Port of Entry Water Treatment Works is designed to treat water from the Limpopo River extracted by means of boreholes (sand wells) in the riverbed. Although the water is relative clean, the works is designed to remove turbidity to levels below 1 NTU, and also to remove iron and manganese to levels meeting the requirements of SANS 241. The treated water is disinfected by means of hypochlorite.

The water supply system consists of the following elements:

2 x Boreholes with a yield of 8 l/s
Approximately 5 km raw water rising main with various air valves
A raw water reservoir on ground level.
A water treatment works.
A clean water reservoir on ground level.
A 60 kl concrete elevated reservoir (20 m height)
Treated water reticulation.

The treatment works consists of the following process components:

In-line dosing of potassium permanganate and a flocculant.
In-line flash mixing (0,3 m to 0,5 m) pressure differential.
Clarification.
Filtration by 5 pressure filters.
Disinfection by hypochlorite.

The capacity of the works is estimated at 600 kl/d.

Potassium permanganate is dosed to oxidise the manganese and the iron in the water for precipitation. The precipitate is flocculated with polyelectrolyte. Sodium hypochlorite is dosed to the centre well of the clarifiers to augment the oxidation reactions.

The water to be treated flows under gravity from the raw water reservoir at ground level through the chemical dosing section to the clarifiers. The dosing pumps have a reported capacity of 10 l/h.

The settled water is pumped by two pumps in duty/standby configuration (submersible) at a rate of 6 l/s and a head of 13 m through the 5 pressure filters to the clean water reservoir. Sodium hypochlorite is also dosed downstream of the filters for the disinfection of the treated water.

The water is pumped from the clean reservoir to the elevated reservoir for distribution to the customers.

The volumes of chemicals are estimated as follows:

Potassium permanganate	0,5 mg/l
HTH	4,5 mg/l
PAC	1,2 mg/l

The above quantities are given as an indication only. The contractor shall make his own estimates on the chemicals to be used.

DH 05.02 PREPARATORY OPERATIONAL TASKS

The preparatory tasks to be executed shall include, but shall not be limited to the items listed in the table below:

DH 04.02	PREPARATORY OPERATIONAL TASKS
01	Satisfy legal and general requirements.
02	Draft inventories of process units, components, materials, etc.
03	Draft process flow diagrams.
04	Derive from available information the design capacity and current load of the works.
05	Assess compliance with relevant design parameters to enable optimal operation of the plant according to its original functionality.
06	Draft plant-specific Operation and Maintenance manuals.
07	Institute required safety measures.
08	Draft template logbook.
09	Draft water balance of water and wastewater system.

DH 05.03 GENERAL OPERATION WORK

General operation of the water care works shall be done in accordance with this specification, with Additional Specification SF: General Operations, and with the Particular Specification related to this work.

The general operation work to be performed and executed shall include, but shall not be limited to the items listed in the table below.

DH 04.03	GENERAL OPERATION WORK	FREQUENCY
1	General housekeeping: Keep site and treatment facilities in neat and acceptable condition.	Daily
2	Control access to the site.	Daily
3	Maintain safety conditions on site.	Daily

4	Log and report pollution events, power failures, extraordinary process phenomena, etc. Check auto-reset of power to mechanical equipment.	Event
5	Calibrate water meters to ensure accurate flow data.	Six-Monthly
6	Record operating hours (and kW-hours where applicable) of all mechanical equipment.	Daily
7	Check operation of all valves and sluices.	Monthly

DH 07.04 **OPERATION OF SPECIFIC PROCESSES AND UNITS**

Operation of specific processes, units and components of the water care works shall be done in accordance with this specification, with Additional Specification SF: General Operations, and with the Particular Specification related to this work.

The specific operation work to be performed and executed shall include, but shall not be limited to the items listed in the table below.

DH 04.06		OPERATION OF SPECIFIC PROCESSES AND UNITS	FREQUENCY
01		**Local authority connection**	
	01	Record residual pressure at connection	Monthly
	02	Calibrate water meter	Annual
	03	Inspect connection for leakage	Quarterly
	04	Record meter reading	Monthly
02		**Boreholes and equipment**	
	01	Check whether pump is operating.	Daily
	02	Record operating hours.	Daily
	03	Record pressure at borehole collar during operation.	Daily
	04	Record borehole water levels at start and stop of pump.	Daily
	05	Check operation of emergency stop switch.	Monthly
	06	Record meter reading.	Daily
	07	Record rainfall: Date, precipitation and duration per event.	Event
	08	Monitor pollution risk (e.g. septic tank or fuel depot close to borehole).	3 Months
03		**River abstraction of raw water**	
	01	Check whether pump is operating	Daily
	02	Record pressure at pump delivery port	Monthly
	03	Check operation of emergency stop switch	Monthly
	04	Check water level in abstraction well at start and stop of pump	Monthly
04		**Raw water storage ports**	
	01	Remove floating material form water surface in pond	Daily
	02	Remove tree and grass roots from verges of pond	6 Months
	03	Record Water level in pond	Daily
05		**Treated water tanks and reservoirs**	
	01	Record water level in tank/reservoir	Daily
	02	Empty and clean tank/reservoir	6 Months

06		**Chlorination**	
	01	Check operation of chlorination facility.	Daily
	02	Ensure chlorine-dosing proportional to flow rate.	Weekly
	03	Measure residual chlorine concentration at outlet of contact tanks (generally the elevated storage tank).	Weekly
	04	Ensure dosage concentration and dosing rates compatible with specification requirements.	Weekly
07		**On-site pipework**	
	01	Flush pipework, tanks and geysers.	6 Months
	02	Measure residual pressure in pipelines.	3 Months
08		**Submersible pumps**	
	01	Check operation and correct switching of pumps.	Daily
	02	Clean pump suction sumps/chambers.	Weekly
	03	Check integrity of power supply and MCC	Monthly
09		**Conventional surface water treatment**	
	01	Check operation of reverse osmosis system	Daily
	02	Record operating hours	Monthly
	03	Record water meter readings	Monthly
	04	Record pressure meter readings during operation	Monthly
	05	Check operation and integrity of cleaning (CIP) system	Daily
	06	Check integrity of, head loss over and flow rate through membrane elements	Monthly
	07	Operate the control system on a daily basis according to supplier's prescriptions, including: Chemical solution preparation, membrane cleaning, sampling, measurement and logging of data	Daily
	08	Check accuracy of chemical dosing rates	Weekly
	09	Manage provision, storage and control of chemicals	Daily
10		**Conventional surface water treatment**	
	01	Check operation of mechanical components of plant	Daily
	02	Ensure correct operating sequence of fill and draw plant	Daily
	03	Select chemicals and dosing rates by means of beaker tests and ensure correct calculation of dosage concentration and dosing rates	6 Months
	04	Ensure mixing intensity (rapid for coagulation and slow for flocculation) commensurate with coagulating chemicals used	6 Months
	05	Record operating hours of plant	Daily
	06	Record water meter readings	Daily
	07	Dispose of treatment sludge on designated site	Daily
	08	Scour settling tank(s) and remove floating solids	Weekly
	09	Backwash filter(s) at required frequency	Daily

	10	Clean submerged portion of settling tank walls by pushing settled sludge on inclined surfaces down to the apex of the cone	Monthly
	11	Manage provision, storage and control of chemicals	Daily
	12	Ensure continuous dosing - avoid pulsing of dosing stream	Daily
13		**Power supply**	
	01	Check operation of stand-by generator where applicable	Monthly

DH 08 MONITORING AND REPORTING

The contractor shall keep a written record of all measurements taken and analyses done for process control and for reporting to relevant authorities in terms of legal or project management requirements.

A logbook shall be kept for daily recording of failures, malfunctions, spills, pollution events, power failures and detail of corrective measures implemented.

The monitoring programme for the above measurements and analyses shall include, but shall not be limited to the items listed in the attached table.

DH 09 MEASUREMENT AND PAYMENT

DH 09.01 REGISTRATION OF A WATER USE ..... Unit : Number

The unit of measurement shall be the number of potable water and sewage treatment plants to be registered. Boreholes are registered as single units. Separate forms are necessary for individual properties, as it is registered at the Surveyor General under its own title dead number. Multiple boreholes on the same property can be registered on the same form by using a summery of the location of each borehole.

The tendered rates shall include full compensation to obtain all relevant information from different authorities (Surveyor General, for instance) to complete the forms. It shall also include full compensation to complete and dispatch the application form

DH 09.02 ENVIRONMENTAL IMPACT ASSESSMENT (EIA): PRE-APPLICATION CONSULTATION, SUBMIT APPLICATION AND PLAN OF STUDY FOR SCOPING AND THE SCOPING REPORT ..... Unit : Number

The unit of measurement shall be to perform the necessary tasks required by the relevant authorities to obtain authorisation for the proposed activity (or activities which may form any entity) up to the acceptance of and the issuing of Records of Decision. This can be performed by the contractor or if required, by the relevant authority, an independent consultant shall be appointed.

The unit of measurement shall be the number of scoping reports compiled by the contractor. The tendered rate shall include full compensation for performing the necessary tasks required by the relevant authorities to obtain authorisation for the proposed activity (or activities which may form an entity) up to the issuing of Record of Decision. Should it be required by the relevant authority that an independent consultant perform this duty such a consultant will be appointed for that purpose by the Department of Public Works.

DH 09.03 **ENVIRONMENTAL IMPACT ASSESSMENT: PLAN OF STUDY FOR ENVIRONMENTAL IMPACT REPORT** ..... Unit : Number

The unit of measurement shall be to do a full Environmental Assessment if it is required by the relevant authority for the proposed activity (or activities which may form an activity), after the scooping report has been reviewed and accepted. The Environmental Impact Assessment shall be conducted by an independent consultant.

The tendered rates shall include full compensation for all the necessary tasks required by the relevant authority to authorise the activity (activities).

DH 09.04 **ENVIRONMENTAL MANAGEMENT PLAN (EMP) DURING REPAIR AND OPERATION** ..... Unit : Number

The unit of measurement shall be number of EMP's compiled by the contractor. One EMP per site will be acceptable.

The tendered rates shall include full compensation for the compilation of an Environmental Management Plan, which will be executed during the repair, maintenance, and operation of a potable water installation and sewerage purification works.

DH 09.05 **REMUNERATION FOR OPERATIONAL RESPONSIBILITIES**

Remuneration for the monthly operation of an installation is determined by a ten point per month scoring system (refer to score card in Technical Specification SF: General Operation of an Installation). The scoring system includes but is not limited to the following operational parameters:

Potable water quality control analysis by an approved authority Quality monitoring programme

Operation of a site laboratory

Tests performed on site to evaluate component performance Record keeping and reporting system

Supply of chemicals necessary for the operation of the plant Operators and supervisors

Tools and equipment for operational needs

Compliance with the required standard (SANS 241 Class 0 or Class 1) . Daily operation of the entire plant to its optimum capacity

Keep site clean, cut/mow weeds and natural grass to a length not longer than 50mm, remove shrubs and small trees from pond walls.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

DH 09.06 **SUPPLY AND DELIVERY OF WATER TREATMENT CHEMICALS & EQUIPMENT** .....Unit: No

The unit of measurement shall be the number of Chemicals supplied.

The tendered rates shall include full compensation for all labour, transport and site handling for the chemicals delivery and storage of the chemicals for the following chemicals:

a) Chlorine in kg or litres
b) Potassium permanganate in kilograms
c) Ultra-floc U3500 in kilograms or litres
d) Pressurised chemical tanks 250L

DH 09.07 SERVICE PUMP CONTROL AND LEVEL SETTINGS ..... Unit: Lump sum

The unit of measurement shall be the Lump Sum.

The tendered rates shall include full compensation for all work required for the service and possible re-installation of the pump control and level settings including the design, manufacture, corrosion protection, patent rights, pre-delivery testing and test certificates, transport for delivery to site and off-loading and installation, including all handling of the equipment of any equipment required for the installation.

DH 09.08 **PROVIDE ADEQUATE LIGHTING AT CLARIFIER** ..... Unit: Lump Sum

The unit of measurement shall be the Lump Sum.

The tendered rates shall include full compensation for the design, manufacture, corrosion protection, patent rights, pre-delivery testing and test certificates, transport for delivery to site and off-loading, installation and commissioning of the lighting system.

DH 09.09 **REPAIR MCC'S, CABLE RACKS AND CABLE TRAYS**..... Unit : number

The unit of measurement shall be the number of plates supplied, installed and commissioned.

The tendered rates shall include full compensation for the site handling and positioning of the equipment, including the fastening of the equipment in its designated position. The following shall also be included in the tendered rates:

DH 09.10 **DECOMMISSIONING AND STRIPPING OF ELEVATED TOWER**..... Unit : Lump Sum

The unit of measurement shall be the Lump Sum.

The tendered rates shall include full compensation for all labour, machinery, tools, transport and site handling necessary for the decommissioning and stripping of the elevated tower.

DH 09.11 **SUPPLY AND INSTALLATION OF NEW VALVES PRESSURE GAUGES AND PIPEWORK**..... Unit : Lump Sum

The unit of measurement shall be the Lump Sum.

The tendered rates shall include full compensation for all components, materials, tools, transport, site handling and labour necessary for the design, manufacture, supply and delivery to site, installation and commissioning of new valves, pressure gauge and pipework.

DH 09.12 **SUPPLY AND INSTALLATION OF NEW OR REFURBISHED STAIRS AND LADDERS**..... Unit : Lump Sum

The unit of measurement shall be the Lump Sum.

The tendered rates shall include full compensation for all components, materials, tools, transport, site handling and labour necessary for the design, manufacture, supply and delivery to site, installation and commissioning of a new rag-catcher.

DH 09.13 **SERVICING EXISTING PERSONAL RO UNITS** ..... Unit: Number

The unit of measurement shall be the number of personal RO units repaired, cleaned and serviced.

The tender rate shall include full compensation for procuring and furnishing all materials, labour, tools and equipment required to repair, clean and service the system including all piping, O-rings, replacement filter elements, filter housings, clamps, tanks and tank-diaphragms as may be required. This must be installed all in accordance with the specification and manufacturer's instructions.

DH 09.14 **REMOVE, SERVICE AND RE-INSTALL EXISTING PERSONAL RO UNITS**.....Unit: Number

The unit of measurement shall be the number of personal RO units removed, reinstalled and serviced.

The tender rate shall include full compensation for procuring and furnishing all materials, labour, and equipment required to remove, reinstall and service the system including all piping, O-rings, replacement filter elements, filter housings, clamps, tanks and tank-diaphragms as may be required. This must be installed all in accordance with the specification and manufacturer's instructions.

DH 09.15 **SUPPLY, INSTALLATION AND COMMISSIONING OF NEW PERSONAL RO UNITS** Unit: Number

The unit of measurement shall be the number of new personal RO units installed.

The tender rate shall include full compensation for procuring and furnishing all materials, labour, and equipment required to install the system including all piping, O-rings, filter elements, filter housings, clamps, tanks and tank-diaphragms. This must be installed all in accordance with the specification and manufacturer's instructions.

DH 09.16 **SUPPLY, INSTALLATION TESTING AND COMMISSIONING OF GATE VALVES, NON-RETURN VALVES, AIR RELEASE VLAVES, BUTTEFLY VALVES, BALL VALVES AND CONTROL VALVES** Unit: No

The unit of measurement shall be the number of valves or sluice gates installed. The tendered rates shall include full compensation for the installation, making good all the damaged corrosion-protected areas, testing, calibration, commissioning and maintenance of the valves or sluice gates and for all other costs and actions necessitated to obtain a complete and efficiently working system. Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

DH 09.17 **SUPPLY DELIVER AND STORE OF SPARE FILTER UNITS MEMBRANES AND SERVICE KITS** ..... Unit: Number

The unit of measurement shall be the number filter elements, membranes, service kits, etc. supplied and stored on site.
The tender rate shall include full compensation for procuring and furnishing and storing all materials.

TECHNICAL SPECIFICATION

DL: CHLORINATION SYSTEMS FOR THE DISINFECTION OF DRINKING WATER AT REMOTE BOREHOLE INSTALLATIONS

CONTENTS

DL 01 SCOPE

This specification states the requirements for all work related to the procurement, installation, testing, commissioning, operation and maintenance of chlorination equipment for the disinfection of drinking water at remote borehole installations. Chlorination equipment shall be provided as one of the following three technological systems, according to site-conditions and the relevant stipulations in this document:

1) Calcium hypochlorite dosing systems.
2) Sodium hypochlorite dosing systems.
3) Vacuum systems for gas chlorination.

Any on-site sodium hypochlorite generators, chlorine dioxide preparation systems or pressure systems for gas chlorination (direct chlorination) shall be deemed UNACCEPTABLE and are all excluded from the scope of this work.

DL 02 STANDARD SPECIFICATIONS

DL 02.01 GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES

The latest edition, including all amendments up to date of tender, of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

SANS 10298	- Indirect small to medium-sized gas chlorination systems for the disinfection of water
SANS 241	- Drinking water
SANS 10306	- The management of potable water in distribution systems
	- Residual chlorine content of water
SANS 6052	

DL 02.02 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act of 1993: Construction Regulations, 2003 as

promulgated in Government Gazette No 25207 and Regulation Gazette No 7721 of 18 July 2003 shall be adhered to.

DL 02.03 MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

DL 02.04 MUNICIPAL REGULATIONS, LAWS AND BY-LAWS

All municipal regulations laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

DL 03 OPERATING AND MAINTENANCE MANUALS

The Contractor shall be responsible for the compilation and production of operating and maintenance manuals including an inventory of all chlorination equipment.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance Manuals. The completion of operating and maintenance manuals shall be a requirement for practical completion.

DL 04 PROCUREMENT AND INSTALLATION OF CHLORINATION SYSTEMS

DL 04.01 GENERAL

Chlorine and hypochlorite are strong bleaching and oxidizing agents and pose a SUBSTANTIAL SAFETY RISK.

The Contractor shall submit proof to the Engineer to demonstrate his (or his subcontractor's) understanding, skill and experience in the assembly of chlorination systems

All chlorine dosing equipment shall be manually adjustable to set accurate dosing rates within the range of average daily flow rates specified. The concentration of chlorine at the point of dosing shall be between 1 – 5 mg/l, so that the free residual chlorine concentration shall be between 0.2 – 1.0 mg/l at the furthest point of use in the water distribution system.

The chlorination system shall be installed in such a way as to dose upstream of overhead tanks/ reservoirs to provide for contact time. Where more than one borehole is used for water supply, the dosing point shall be installed in a common rising main, upstream of the overhead tanks/ reservoirs.

DL 04.02 CALCIUM HYPOCHLORITE DOSING SYSTEM

Calcium hypochlorite dosing shall be the system of choice for disinfection at small remote bore-hole water supply installations.

Calcium hypochlorite can be supplied as briquettes, chips or pellets. Chlorinators shall be designed to provide a consistently accurate dose of available chlorine to small

water systems. Corrosion resistant plastics (polyethylene) shall be used in the product's construction.

All $Ca(ClO)_2$ supplied shall have a chlorine content of between 65 and 70% and an average moisture content of less than 4%. Calcium hypochlorite shall be properly packaged prevent contact with moisture and to ensure safety of handling. A shelf life of at least 3 months shall be maintained for supplied calcium hypochlorite.

The dosing plant uses a dry chemical product that is dissolved in water to make-up the required chlorine containing solution. When the chemical make-up tank is empty a specified mass of the chemical is added to the tank as it is filled with water to make up the required concentrate of chemicals in the solution.
The chemical solution used on this systems is 1,7% of Calcium Hypochlorite (*1,13% Cl)

Note*: Calcium Hypochlorite contains 68% chlorine

The principal of making up the chemical is to top up the tank once per week so that the tank is operating of the top half of the tank. This is done at the time of performing the weekly operational tasks. The level of the solution in the tank is used, as the indicator of how much chemical has to be added when performing the topping up task. If this is done, the concentrate of the chemical solution will stay constant.

The calcium component of the Calcium Hypochlorite will precipitate and cause a white settlement in the dosing tank. This settled white substance that accumulates at the bottom of the tank is not chlorine and needs to be cleaned out on a regular cycle as described in the three monthly procedures. The tank is used to its lowest operating level (15%) before executing the three monthly cleaning procedures.

Dosing proportionate to flow shall be done with displacement pulse dosing pump with electronic control, interlinked with flow meter, read switch pulses.

DL 04.03 **SODIUM HYPOCHLORITE DOSING SYSTEM**

Sodium hypochlorite is a colourless, transparent liquid, which shall be dissolved in cold water to a concentration of between 8 – 10% for liquid dosing. Sodium hypochlorite shall be safely stored, located it in a cool, dark place, maintaining pH 11 or more and avoiding contact with copper or nickel.

The size of dosing tank shall be dimensioned such and kept at a maximum level to Tank level Markings ensure that sodium hypochlorite (NaOCl) does not break down to NaCl and NaOH.

A UV-stabilized polyethylene (PE) off-white or semi-transparent dose tank is required, with a sintered drain-off connection and 4 lateral mounting places at the bottom on the tank shell. The dose tanks shall be optimized for stability and functionality.

The dosing apparatus shall be robust and shall not cause blockages. The dosing apparatus shall ensure absolutely precise dosing through a dosing process that is always strictly proportional to the quantity of water flowing through the main delivery pipe. This could be achieved through a flow meter in the dosing apparatus. The following special features shall be required:

(i) adjustable dosing capacity that avoids over- or under-dosing

(ii) automatic stop of an overload-proof synchronous motor under conditions of short-term pressure shocks, with automatic re-start when pressure drops to normal again

(iii) a control LED that indicates pump stokes, with a second LED that flashes if the liquid level becomes too low causing the dose pump to switch off automatically: the empty indication is directly combined with the suction line for this purpose.

DL 04.04 VACUUM GAS CHLORINATION SYSTEM

Vacuum gas chlorination systems shall only be considered where average daily flow rates are more than 8 l/s (i.e. around 700 m^3/d). The mean residence time of gas cylinders shall never be more than two months. Gas cylinders shall be mounted on mechanical balances.

Pressure systems feeding pressurized gaseous chlorine directly into the water supply system shall not be acceptable.

A dual system with two cylinders is required, including an automatic change-over device to switch between cylinders that shall be installed with a wall mounted manifold.

All chlorination equipment and ancillaries, the layout and installation, materials, operational safety measures and maintenance shall be strictly in accordance with SANS 10298.

DL 04.05 SAFETY SIGNS AT CHLORINATION INSTALLATION

Regardless of the type of chlorination system installed, warning signs shall be installed at the chlorination systems to be clearly visible. Warning signs shall also include all safety precautions for the operation and maintenance of chlorination systems, in accordance with the manufacturer's specifications and other relevant safety specifications and acts. A warning sign with first aid instructions shall also be installed at the chlorination system, specifying instructions for instances of skin exposure, eye exposure, inhalation exposure and swallowing, according to the manufacturer's specifications and SANS 10298.

DL 05 TESTING AND COMMISSIONING

After installation, the contractor shall evaluate the functioning of chlorination systems to ensure that there are no leaks and that the rate of dosing is set correctly.

DL 06 DESCRIPTION OF INSTALLATION

DL 06.01 BULK WATER

Water is pumped from multiple boreholes with borehole pumps and delivered into the elevated bulk storage tanks.

The boreholes are switched on and off to maintain a "full tank status". This manual does not cover details regarding the control of the boreholes.

An analysis of the borehole water indicated that the physical properties of the water were suitable for human consumption. The only treatment that the water requires is to

dose it with a small quantity of chlorine so that any harmful bacteria and microorganisms that may enter the water can be destroyed.

A system was designed to dose chlorine at a rate of 0,5 to 2-mg/l. The object is to have a residual of chlorine left in the water so that by the time it reaches the user. The traceable presence of free chlorine should be between 0,2 to 0,5 mg/l. the dosing pump can be adjusted up or down to achieve the required residual.

The flow rate from the boreholes could vary depending on which of the boreholes are active and in which combination the boreholes are used. To maintain a constant dosing ratio (mg/l) the dosing facility has to be able to keep pace with possible fluctuations of flow from the boreholes.

"Proportionate to flow" takes place as follows:

A water meter is used to measure the volume of water that is delivered from the boreholes to the storage tanks. This water meter is equipped with a sensor that gives one pulse for every 100L of water that has passed through the meter to the storage facility.
A chemical dosing pump is used to dose a chlorine containing solution from the chemical make-up tank into the pipeline, before the water enters the storage tanks.
The pulses from the water meter is received by an Alldos dosing pump or equivalent with Etron electronics.
Each pulse, as received from the water meter, is used to start the dosing pump and introduce a set volume of the chlorine containing solution into the pipeline to maintain the required chlorine-dosing ratio

The dosing pump can be set to manual mode in case of failure of the signal from the water meter.

DL 06.01 WASTEWATER TREATMENT WORKS

The wastewater treatment works consists of a 180kg Chip Dozer with a capacity capable of holding 180kg Calcium Hypochlorite chips Scientific Chips.

The maximum feed rate is 50kg chips per hour and the system is capable of handling a flow rate 40-4000 litre water per hour. Is also consists of a double rotameter system with a 2000 litre maximum flow per rotameter.

The system must be regularly cleaned to prevent build-up and blockages. The cleaning procedure will form part of the maintenance and operation requirements.

DL 07 OPERATION AND MAINTENANCE

DL 07.01 GENERAL

Maintenance shall be carried out according to an approved maintenance plan and operation and maintenance manual, which shall specify actions including routine preventative maintenance according to the manufacturer's specifications, as well as unforeseen repair work, corrective maintenance and/or replacement of parts of the system.

DL 07.02 **OPERATION AND ROUTINE PREVENTATIVE MAINTENANCE**

The tasks related to the operation and routine preventative maintenance work shall include but not be limited to the GENERAL actions listed in table DL 07.02/1 below. SANS 241 shall be adhered to in the routine preventative maintenance of vacuum systems for gas chlorination.

These actions and findings shall be logged and reported on the relevant approved schedules and reports.

TABLE DL 07.02/1

NO	ROUTINE PREVENTATIVE MAINTENANCE OF CHLORINATION SYSTEMS AND ANCILLARIES	MAINTENANCE FREQUENCY
1	Visually inspect and report on complete system.	Daily
2	Clean complete installation thoroughly so that leaks would be obvious and clear when they occur.	Weekly
3	Check, service, repair and clean dosing apparatus from blockages.	Monthly
4	Corrosion protect all equipment and ancillaries.	Whenever necessary
5	Check for and repair all leaks. Report leaks.	Monthly
6	Check dosing rate and reset regulators if necessary.	Monthly
7	Measure residual chlorine in the drinking water system (DPD 4 or similar).	Weekly

DL 07.03 **OPERATION**

Operation of all chlorination systems shall include the supply of chemicals, including chlorine gas or sodium hypochlorite or calcium hypochlorite. The contractor shall supply chemicals to ensure that there is always enough supplied for a full month's requirement.

DL 07.04 **SAFETY PROCEDURES AND PRE-CAUTIONS**

SANS 10298 specifies operational safety in terms of general safety requirements, emergency action plans, personal protective equipment and handling of containers, which shall at all times be adhered to. Only personnel who are adequately trained shall be allowed to operate and maintain the chlorination systems.

DL 07.05 **REMUNERATION**

Remuneration for the monthly operation of chlorination systems, the supply of chlorine or hypochlorite as well as ALL maintenance activities related to chlorination systems shall be deemed included in the tendered rate for ten points of the installation of which the system forms part. Installations are specified in Additional Specification SA: General Maintenance.

DL 08 **MEASUREMENT AND PAYMENT**

DL.08.01 **SUPPLY AND DELIVERY OF CHLORINATION SYSTEMS** ..... Unit: number

The unit of measurement shall be the number of chlorination systems supplied and delivered, including all equipment and ancillaries deemed part of a functional system.

The tendered rates shall include full compensation for the design, manufacture, corrosion

protection, patent rights, pre-delivery testing and test certificates. Different systems as specified in this document shall be listed in the Schedule of Quantities, according to:

i) Calcium hypochlorite dosing systems.
ii) Sodium hypochlorite dosing systems.
iii) Vacuum systems for gas chlorination.

Tendered rates shall include full compensation for all transport cost, including all handling of the equipment, loading and off-loading of chlorination systems.

Different systems shall be based on the daily average flow rate of the main water supply.

DL.02 **INSTALLATION, TESTING AND COMMISSIONING OF CHLORINATION SYSTEMS** .....Unit: number

The unit of measurement shall be the number of chlorination systems installed, tested and commissioned.

The tendered rates shall include full compensation for the site handling and positioning of the chlorination equipment, including the fastening of the equipment in its designated position. The following shall also be included in the tendered rates:

(a) Installation of all equipment, ancillaries and all other necessary appurtenances required to render a fully functional chlorination system;
(b) Coupling of all required pipes flanges, including all required gaskets, nuts, bolts and washers;
(c) Routing and fastening of all power cables, connecting of all electrical material and switchgear;
(d) All required installation materials, labour and consumables to render a complete and working installation.

The tendered rates shall also include full compensation for all preliminary tests, delivery and efficiency tests if required and commissioning tests to ensure a leak-free system and the correct settings of regulators to ensure accurate dosing.

Separate items will be listed in the Schedule of Quantities for different types and sizes of systems, as specified under payment item DL.01.

TECHNICAL SPECIFICATION

DN: CLEAR-WATER PUMP SYSTEMS

CONTENTS

DN 01 SCOPE

This specification covers the decommissioning, removal, repair and reconditioning, installation, testing, commissioning and maintenance of pumping equipment, motor control devices and low-voltage cables. The function of clear-water pump systems shall be the delivery of water at a specified flow rate and head to the required location.

This specification shall form an integral part of the maintenance and servicing contract document and shall be read in conjunction with portion 3: Additional Specifications included in this document.

This specification shall act as a guideline to the Particular Specification and, in the event of any discrepancies between the Technical Specification and the Particular Specification, the latter shall take precedence.

DN 02 STANDARD SPECIFICATIONS

DN 02.01 GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES

The latest edition, including all amendments up to date of tender, of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

BS 5316, Part 1	-	Acceptance tests for centrifugal, mixed flow and axial pumps
SABS 948	-	Three-phase induction motors
SANS 1222	-	Enclosures for electrical equipment (classified according to the degree of protection that the enclosure provides)
BS 4999	-	General requirements for rotating electrical machines
BS 1486, Part 2	-	Heavy duty lubrication nipples
ISO 281/1	-	Rolling bearings – dynamic load ratings and rating life

DN 02.02 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act of 1993: Construction Regulations, 2003 as promulgated in Government Gazette No 25207 and Regulation Gazette No 7721 of 18 July 2003 shall be adhered to.

DN 02.03 MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

DN 02.04 MUNICIPAL REGULATIONS, LAWS AND BY-LAWS

All municipal regulations laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

DN 03 AS-BUILT INFORMATION AND OPERATING AND MAINTENANCE MANUALS

The Contractor shall at the start of the Contract be given all available as-built information and operating and maintenance manuals.

The Contractor shall be responsible for the compilation of an inventory list and operating and maintenance manuals.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance Manuals.

DN 04 PUMP DESIGN AND REQUIREMENTS

(a) The pump shaft shall be manufactured from stainless steel and shall be sealed where it enters the casing with double mechanical face seals.

(b) The impeller shall be suitable for pumping the type of clear water as specified in Clause DN 08 (Detail of work) of this specification.

(c) The impeller shall be manufactured from stainless steel or, in the case of other materials, it shall be coated with an approved material resistant to abrasion and corrosion prevalent to the conditions under which the impeller shall operate. For pumps rated below 2 kW non-metallic impellers may be utilised.

(d) The impeller shall be statically, dynamically and hydraulically balanced. No in holes may be drilled on the impeller to balance it with regard to mass distribution.

(e) Only permanently sealed ball or roller bearings shall be installed.

(f) Bearings shall have a B-10 life rating of 100 000 hours.

(g) The pump shall be a currently catalogued product.

(h) Performance curves shall be based on a reproducible and certified test carried out in an approved testing facility, such as the SABS.

(i) The flow rate at break-off point of the curve for the impeller selected shall be at least 1,5 times that of the maximum flow rate specified.

(j) The head at zero delivery of the curve of the impeller selected shall be at least 1,2 times the maximum head in the pump's operational range.

(k) Each pump shall be clearly labelled. The label shall be a 0,5 mm thick stainless steel plate of dimensions 100 mm x 50 mm. The label shall be fixed to the pump exterior with an approved adhesive or other method after the completion of corrosion protection on the pump. It may be bent to follow the shape of the pump exterior but shall not be bent to accommodate sharp folds. Under no circumstances shall the stainless steel plate of the label influence, damage or otherwise have a detrimental effect on the corrosion protection system. The label shall include the following information:

- Pump rates
- Pump head
- Power required
- NPSH (r) rotational speed
- Impeller detail.

(l) All new submersible pumps shall be supplied with a length of power cable to suit the installation shown on the drawings.

(m) All new pumps shall be fitted with double flush mechanical seals, which shall be included in the cost of the pumps. The pump shafts shall be hardened and accurately ground where the seal bears on the shaft. The rotating seal face shall be mounted on a flexible member, sealing on the shaft as well. The flexible member shall be manufactured from rubber, PTFE or equivalent material suitable for the operating environment.

(n) Centrifugal pumps shall comply with relevant and applicable items under the clause on technical requirements regarding all pump types, as well as the following:

(i) Preference shall be given to pumps of the self-regulating type and where the power consumption characteristic is such that the power consumption decreases with an increase in delivery to beyond a certain limit, thus ensuring that the motor is not overloaded in the event of a large reduction in pumping head.

(ii) The casing for centrifugal pumps shall be horizontally or vertically split to allow removal of parts.

(iii) The efficiency of the pump shall not be less than 95 % of its maximum efficiency at the selected operating point, where the latter shall not be less than 80 %.

DN 05 MOTOR DESIGN AND REQUIREMENTS

(a) Electric motors shall comply with the requirements of SABS 948

(b) Imported motors forming an integral part of the pump shall be submitted to the South African Bureau of Standards to be tested in accordance with the requirements of SABS 948.

(c) All motors shall be standard catalogue models and shall be readily available.

(d) All motors shall, where possible, be from the same manufacturer and shall have the same interchangeable frames. Variations in type and size shall, where possible, be limited to make stocking a variety of special spares unnecessary.

(e) All motors shall have dynamically balanced rotors supported by maintenance-free, sealed-for-life ball bearings.

(f) All motors shall be suitably coated to ensure the satisfactory operation of the motor under the specified class of service.

(g) All terminal boxes shall be waterproof and suited for submersion up to the depth as specified for the pumps.

(h) An adequate length of waterproof cable, purpose-made for submerging, shall be supplied with each submersible motor. The coupling of this cable to the normal power-distribution cable, which usually is of the PVC type with steel-wire armour, shall be placed at least 1,0 m above the maximum water level by means of a purpose-made, weatherproof, outdoor junction box. The submerged cable shall be supported to minimise any movement of the cable, which result from turbulence caused by the operation of the equipment or the flow of the water.

(i) Thermistor protection or Klixon type temperature switches shall be provided for submersible motors.

(j) Seal monitors shall be provided for submersible motors, together with the required seal monitor relays. The cost for the seal monitor relays shall be deemed to be included in the rates tendered for the equipment.

DN 06 WORKING VOLTAGE AND SUPPLY SYSTEMS

The motors shall be capable of operating within ± 10 % of the nominal supply voltage without risk of damage. All motors shall be suitable for operating continuously at the specified three-phase voltage system under actual service conditions, including the ± 10 % voltage tolerance, without exceeding the specified temperature rise determined by the resistance on a basic full load heat run.

All motors shall be capable of operating continuously under actual service conditions at any supply frequency between 48 and 51 Hz together with any voltage between ± 5 % of the nominal supply voltage.

The slip-in speed of any motor at 80 % of the nominal voltage at 50 Hz shall not exceed a percentage agreed on by the Engineer, and the motors shall be capable of operating at this voltage for a period of five minutes without deleterious heating.

DN 07 PROTECTION AND CONTROL DEVICES

Submersible pumping equipment shall have float switches to switch the pump motor on and off, according to the level of the liquid. Switches shall operate freely and not be hindered by cables or other switches and shall switch off at a level where no damage to the pump or motor will occur.

Three level switches shall operate a pump control system:

(a) Level switch one shall switch off pumps at low level;

(b) Level switch two shall switch on one pump at an intermediate level, to draw the liquid down to level 1. When the level again rises to where level switch two was switched on, the pump duty shall rotate and start the motor parallel to the one which ran the first time;

(c) Level switch three shall switch on both pumps to run in parallel at a high level.

In the event of a pump failing to start, the other pump must automatically be

restarted. Pumps shall be operated in both manual and automatic modes.

DN 08 DETAIL OF WORK

DN 08.01 GENERAL

The Contractor shall investigate and inspect all areas of the installation to confirm the extent of the repair work required and shall report to the Engineer. The Engineer will thereafter demarcate any areas to be repaired and shall instruct the Contractor with regard to the repair work to be done.

DN 08.02 TESTING EQUIPMENT

All electrical and mechanical equipment shall be checked at the start of the Contract to establish which items need to be repaired, reconditioned or replaced.

DN 08.03 BULK WATER PUMP SYSTEM

The exiting bore hole pumps are in a working order and replacement of one bore hole pump were allowed for in the bill of quantities.

Exiting motor control centres will be reconditioned to comply with the requirements of DN 08.05.

New motor control centres will be installed to comply with the requirements of FN 08.05.

DN 08.04 MOTOR CONTROL CENTRE

(a) The inside and outside of all surfaces of the motor control centre must be thoroughly cleaned and metal surfaces treated for rust and corrosion and repainted to specification.

(b) Float switches for level sensing shall be checked. Missing, damaged or faulty switches shall be replaced with new switches of similar and equal type. The switches must be installed and supported on suitable brackets to prevent the cables and switches from tangling, due to the inflow of the sewage water.

(c) Check and tighten all terminations of all equipment.

(d) Clean out all switchgear and equipment properly to remove dust and spider webs.

(e) Dismantle and clean all moving parts and contacts of magnetic contactors and starters, reassemble, check overload trip units and adjust correctly. Test for correct functioning on completion of repair work.

(f) Replace any damaged ammeters, switches and lamps on the control with parts similar and equal to the existing types on the panel.

(g) Wiring diagrams of all electrical panels and MCC panels shall be compiled.

DN 08.05 STANDARD MOTOR CONTROL CENTRE REQUIREMENTS

(a) The new replacement motor control centre for the water pumps shall be wired to comply with the requirements as set out in this clause.

(b) The motor control centre shall be of the free standing, weatherproof, corrosion resistant

(c) Motor Control Centre panel material must be of 2.0 mm thick IP65, 3CR12, coated steel.

(d) The face plate of the motor control centre must be inside the complete panel and the complete panel must have a lockable door, capable of locking with a padlock.

(e) The faceplate of the motor control centre must have a lockable isolator to ensure that the panel if off when the face plate cover is opened.

(f) The power supply cable from the MCC to the pump shall be tested for conformity to be re-used. In the event that the cable might not pass such testing by the Contractor, the Contractor shall inform the Engineer in writing. The Engineer will instruct the Contractor with regard to a new cable to be installed. *Remuneration, in the event of a new power supply cable being required from the MCC to the pump, will be measured under the re-measurable electrical repair quantities and must* ***not*** *be included in the payment item for the replacement and equipping of the Motor Control Centre!*

(g) Provide an engraved label on the door of the MCC with the relevant MCC number on. The label shall be secured with screws and nuts.

(h) The existing level float switches will be tested and replaced if defective.

(i) Switchgear and equipment shall be installed in the MCC to indicate and ensure:

Automatically regulate the start and stop of the pumps
- Indicate the time that the pumps has been operating since commissioning (hour meters)

Start/ stop the pumps manually
- Indicate that the pumps is running
- Indicate that the pumps has tripped
- Indicate Amps for each pump
- Indicate main supply Voltage (L1, L2 & L3) & ((L1/L2, L2/L3 & L3/L1) Ensure phase failure protection

Insulation resistance before start-up
- Temperature (Tempcon, Pt sensor and PTC/thermal switch or equivalent)

Overload/under load
- Overvoltage/under voltage Phase sequence

Power factor
- Power consumption
- Harmonic distortion
- Run and start capacitor (single-phase)
- Operating hours and number of starts
- Lightning and surge protection

(j) Test for correct functioning on completion of electrical repair work.

(k) Emergency stop buttons shall be installed at the pump in weather boxes for emergency stop functions.

DN 08.05.01 SPECIFIC REQUIREMENTS FOR BOREHOLE PUMPS

(a) The borehole pump motor control centres for Beitbridge shall operate automatically by means of switching off when there is no flow in the pipe line or when the pressure exceeds the maximum working pressure.

(b) The motor control centre will then restart the pump after a set time duration and follow (a) again.

(c) The motor control centre must be able to operate the pump in accordance with the set working time per day. (7day/24hour timer).

DN 09 TESTING AND COMMISSIONING

DN 09.01 TEST TO BE PERFORMED

(a) All pumping equipment shall be subject to the commissioning tests as described in the applicable specification.

(b) At least one of each type or size of pump supplied, repaired or reconditioned, shall be subject to a delivery flow rate test. The Contractor shall supply flow rate or volumetric flow testing facilities.

(c) The operating point of each pump shall be determined.

(d) Efficiency tests shall be performed.

(e) NPSH tests shall be performed.

DN 09.02 PUMP OPERATING POINT

During the day 1 commissioning tests the pump operating point shall be determined by observing the following:

(a) pump delivery and suction pressures, and
(b) electric motor power consumption.

If no efficiency tests are required, then the motor power consumption shall be calculated from the voltage and current measurements obtained during the commissioning test.

The Contractor shall supply the necessary adaptors, fittings and pressures gauges to measure the suction and delivery pressures. If no gauge fittings exist on the suction side, then the suction pressure conditions will be calculated from the system properties.

DN 09.03 FLOW RATE (DELIVERY), EFFICIENCY AND NPSH TESTS

(a) Testing shall be done in accordance with BS 5316 Part 1, class C tests.

(b) Power consumption of electric motors shall be as determined by the three-wattmeter method where efficiency tests are required in the detail specification.

DN 09.04 TEST CONDITIONS

(a) All tests shall be performed in situ.

(b) The pumped medium or liquid shall be water.

DN 09.05 ADDITIONAL TESTS

Additional tests may be specified in the detail of work.

DN 10 MAINTENANCE

DN 10.01 GENERAL

All pumping equipment and systems shall be serviced and repaired, following practical completion of the installation of which it forms part, to maintain it in perfect functional condition.

Maintenance of the swimming pool with its associated equipment, as well as frequent cleaning of the strainer, sand-filter and mechanical cleaning of the pool shall form part of the maintenance responsibility of the Contractor, as defined in this specification. The maintenance responsibility shall include supply and addition of any chemicals that might be necessary for the maintenance of the water quality of the swimming pool.

Maintenance shall be carried out and shall include routine preventative maintenance according to the manufacturer's specification to be set out in the operating and maintenance manual, as well as unforeseen repairwork or replacement.

The remuneration for monthly maintenance of pumping equipment and systems shall be deemed included in the tendered rate for 10 points of the installation of which the system forms part. Installations are specified in Additional Specification SA: General Maintenance, and illustrated in detail on the mechanical flow diagram.

DN 10.02 ROUTINE PREVENTATIVE MAINTENANCE

The routine preventative maintenance work to be carried out shall include but not be limited to the items listed in table DN 10.2/1 below.

These actions and findings shall be logged and reported on the relevant approved schedules and reports.

TABLE DN 10.02/1

NO	ROUTINE PREVENTATIVE MAINTENANCE OF CLEAR-WATER PUMP SYSTEMS	MAINTENANCE FREQUENCY
1	Visually inspect and report on complete systems	Monthly
2	Check, service, repair and clean all pumps	Six-monthly
3	Check, service, repair and clean all motor control centres and level censing devices.	Six-monthly
4	Corrosion protect pumps, motors and surface piping	As required
5	Check, inspect, report and repair all leaks	Monthly
6	Check and lubricate moving parts	Six-monthly

DN 11 MEASUREMENT AND PAYMENT

DN 11.01 SUPPLY AND DELIVERY OF PUMPING EQUIPMENT ..... Unit: number

The unit of measurement shall be the number of pumping equipment units supplied and delivered.

The tendered rates shall include full compensation for the design, manufacture, corrosion protection, patent rights, pre-delivery testing and test certificates, transport for delivery to site and off-loading, including all handling of the equipment. The equipment shall include the following:

(a) The pump and motor as an integrated unit

(b) Electrical power cable.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

DN 11.02 **INSTALLATION, TESTING AND COMMISSIONING OF PUMPING EQUIPMENT**..... Unit: number

The unit of measurement shall be the number of pumping equipment units tested and commissioned.

The tendered rates shall include full compensation for the site handling and positioning of the pumping equipment, including the fastening of the equipment in its designated position. The following shall also be included in the tendered rates:

(a) Installation of the guide rails and sealing frame;
(b) Coupling of all required pipes flanges, including all required gaskets, nuts, bolts and washers;
(c) Routing and fastening of the power cable up to the isolator box;
(d) All required installation materials, labour and consumables to render a complete and working installation.

The tendered rates shall also include full compensation for all preliminary tests, delivery and efficiency tests if required and commissioning tests. Commissioning tests shall comply with the section dealing with testing and commissioning.
Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

DN 11.03 **DECOMMISSIONING AND REMOVAL OF VALVES**..... Unit: number

The unit of measurement shall be the number of valve units decommissioned and removed.

The tendered rates shall include full compensation for all labour, machinery, tools, transport and site handling necessary for the decommissioning and removal of Valves as specified in the schedule of quantities.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

DN 11.04 **RECONDITIONING OF VALVES**..... Unit: number

The unit of measurement shall be the number of valves reconditioned.

The tendered rates shall include full compensation for replacement of components and materials, and for tools, transport, site handling and labour necessary for the complete reconditioning of valves to conform to all the specifications in Clauses DN 04: Pump design and requirements, and DN 05: Motor design and requirements.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

DN 11.05 **REPAIR OF PUMPING EQUIPMENT**..... Unit: number

The unit of measurement shall be the number of pumps and motors repaired.

The tendered rate shall include full compensation for supply of an identification label, resetting the spacer between impeller and back plate and ensuring that impeller rotates freely, as well as cleaning and corrosion protection and installing a new hoisting chain.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

DN 11.06 **SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF MCC BOARDS OR OTHER ELECTRICITY BOARDS** ..... Unit: number

The unit of measurement shall be the number of MCC boards or other electricity boards supplied.

The tendered rates shall include full compensation for supply of the complete motor control centre as per the requirement in the specification and components and materials and for tools, transport, site handling and labour necessary for supply of a fully functional MCC board. Including the issuing.
of Certificate of Compliance

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

DN 11.07 **DECOMMISSION, RECONDITION, TEST AND COMMISSION MCC BOARDS OR OTHER ELECTRICITY BOARDS** .....Unit: number

The unit of measurement shall be the number of MCC boards or other electricity boards reconditioned.

The tendered rates shall include full compensation for replacement of existing components and materials and for tools, transport, site handling and labour necessary for the complete reconditioning of all components of the board or replacement of all components to provide a fully functional MCC board in accordance with the specification. Including the issuing. of Certificate
of Compliance

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

DN 11.08 **COMPILATION OF WIRING DIAGRAMS** ..... Unit: number

The unit of measurement shall be the number of wiring diagrams compiled.

The tendered rates shall include full compensation for drawing, printing, computer time and any other associated costs necessary for the compilation of a wiring diagram.

DN 11.09 **RECONDITIONING OF TELEMETRIC SYSTEMS** ..... Unit: number

The unit of measurement shall be the number of telemetric systems repaired/ reconditioned.

The tendered rates shall include full compensation for replacement of components and materials and for tools, transport, site handling and labour necessary for the complete reconditioning/repair of all components of the telemetric system.

DN 11.10 **SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF VALVES** ..Unit: number

The unit of measurement shall be the number of valves supplied.

The tendered rates shall include full compensation for supply of the complete valve unit as per scheduled quantities including materials, tools, transport, site handling and labour necessary for the supply, installation, testing and commissioning of valves.
Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

TECHNICAL SPECIFICATION

DW: WATER SUPPLY

CONTENTS

DW 01 SCOPE

Procure, deliver and discharge, into the storage container(s) at each facility, potable water complying with the specified quality standards.

DW 02 STANDARD SPECIFICATIONS, REGULATIONS AND CODES OF PRACTICE

The supply of water is to be undertaken in compliance with the relevant specifications, regulations and/or codes of practice included in the following publications.

- SANS 241 of 2006 - South African Standard Specification for Drinking Water*
- SANS 10252-2: 1993 – Code of Práctice "Water Supply and Drainage for Buildings, Part 2: Drainage Installations for Buildings" – Annexure B – Septic Tank Systems*
- National Water Act, Act No 36 of 1998**
- Occupational Health and Safety Act, No 85 of 1993*

DW 03 DETAIL OF WORK

DW 03.01 PROCUREMENT OF WATER

DW 03.01.01 Procurement of potable water

Water of quality in compliance with the latest Version of the South African Standard Specification for Drinking Water, SANS 241 and volume to meet the facility requirements is to be procured on a legal basis from a source(s) identified by the Contractor. Written proof of purchase, quantity, quality and date(s) is to be provided with the Contractors application for payment for services provided under the Contract.

DW 03.01.02 Procurement of raw water

Raw water is to be procured on a legal basis from a source(s) identified by the Contractor. Written proof of purchase, quantity, quality and date(s) is to be provided with the Contractors application for payment for services provided under the Contract.

DW 03.02 DELIVERY OF WATER TO FACILITIES

DW 03.02.01 General

The Contractor shall deliver the water to facilities on instruction from the Engineer within 24 hours.

DW 03.02.02 Delivery of potable water

The Contractor shall ensure that the water is not contaminated during delivery and upon discharge into the facility storage container(s) and must comply with the following macro- and micro-determinants and bacteriological limits:

MACRO- AND MICRO-DETERMINANTS	
1	2
Determined mg/	**Class 1**
Turbidity	1
Magnesium (as Mg)	70 max.
Sodium (as Na)	200 max.
Chloride (as Cl)	200 max.
Sulphate (as So_4)	400 max.
Nitrate + nitrite (as N)	10 max.
Fluoride (as F)	1.0 max.
Zinc (as Zn)	1.0 max.
Aluminium (as Al)	0.3 max
pH	6.0 - 9.0
Conductivity	150 mS/m
Iron	0.2
Manganese	0.1

MICROBIOLOGICAL REQUIREMENTS				
1	2	3	4	5
Determinants	**Units**	**Allowable compliance contribution**		
		95% of samples, min	**4% of samples max**	**1% of samples max**
		Upper limits		
Heterotrophic plate count	Count/ml	100	1000	10000
Total coliform bacteria	Count/100 ml	Not detected	10	100
Feacal coliform bacteria	Count/100 ml	Not detected	1	10

DW 04 PLANT: TRANSPORT

The Contractor shall ensure that the type, condition and capacity of the vehicle(s), including standby vehicles, to be used is sufficient to fulfil the obligations of the Contract. The transport operation shall be undertaken in compliance with relevant transport ordinaries.

DW 05 TESTING

The Contractor is responsible to ensure that tests required ensuring compliancy with the specifications and ordinaries relating to the quality of water, are undertaken at the frequency and in terms of procedures prescribed.

DW 06 PAYMENT ITEMS

DW 06.01 **Supply units of 1000 litres (m^3) of potable water from commercial sources on the instruction of the Engineer/Department's representatives** ..... Unit: m^3

The unit of measurement shall be the number of cubic metres of potable water delivered to site within 24 hours from the time that the Engineer has logged an emergency breakdown call with the Call Centre.

The tendered rate shall include full compensation for the labour, materials and equipment needed to supply potable water into the elevated storage tank as directed by the engineer.

The tendered rate shall include, initial testing of water quality, value related as well as all time related preliminary and general charges, the operation and maintenance cost of the vehicle and the remuneration costs of the driver and workers. Separate items will be listed in the schedule of quantities for different rates of delivery.

DW 06.02 **Supply and delivery units of 1000 litres (m^3) of potable water from existing sources within a 3km radius on the instruction of the Engineer/Department's representatives** ..... Unit: m^3

The unit of measurement shall be the number of cubic metres of potable water delivered to site within 24 hours from the time that the Engineer has logged an emergency breakdown call with the Call Centre.

The tendered rate shall include full compensation for the labour, materials and equipment needed to supply and deliver potable water into the elevated storage tank as directed by the engineer.

The tendered rate shall include, initial testing of water quality, value related as well as all time related preliminary and general charges, the operation and maintenance cost of the vehicle and the remuneration costs of the driver and workers.

DW 06.03 **Supply units of 1000 litres (m^3) of raw water on the instruction of the Engineer/Department's representatives** ..... Unit: m^3

The unit of measurement shall be the number of cubic metres of raw water delivered to site.

The tendered rate shall include full compensation for the labour, materials and equipment needed to supply and deliver raw water into the raw storage tank or raw storage dams as directed by the engineer. It shall be possible to treat the raw water with the existing water treatment works on site to a standard that is in compliance with the South African Standard Specification for Drinking Water, SANS 241: 2006.

The tendered rate shall include, initial testing of water quality, value related as well as all time related preliminary and general charges, the operation and maintenance cost of the

vehicle and the remuneration costs of the driver and workers. Separate items will be listed in the schedule of quantities for different rates of delivery.

DW 06.04 **Delivery of potable water from commercial sources on the instruction of the Engineer/Department's representatives** ..... Unit: km

The unit of measurement shall be the number of kilometres travelled from the commercial source approved by the Engineer delivered to the storage tank.

The tendered rate shall include full compensation for the labour, materials and equipment needed to transport potable water into the elevated storage tank as directed by the engineer.

The tendered rate shall include, value related as well as all time related preliminary and general charges, the operation and maintenance cost of the vehicle and the remuneration costs of the driver and workers.

DW 07.01 **Water treatment system Audit .....Unit: sum**

The unit of measurement shall be the sum rate for conducting all works describe hereunder by a qualified process engineer/scientist (Pr Eng/Pr Sci Nat) on a once off basis to be carried out within 3 months post the site handover.

The tendered rate shall include full compensation for the labour, materials and equipment needed. The audit shall include the following:

a) Water Safety Plan
b) Risk Assessment
c) Asset register
d) Plant process audit'

As per Blue Drop Regulation

CIVIL WORKS

WASTEWATER WORKS

TECHNICAL SPECIFICATIONS

SECTION EA- EQ

TECHNICAL SPECIFICATION

EA: WASTEWATER INLET WORKS

CONTENTS

EA 01 SCOPE

Wastewater inlet works shall mean all materials, units, components and equipment, and their relation to each other, employed to enable reliable screening, grit deposition and flow measurement of water at a variety of flow rates.

This specification covers the supply, delivery, repair, installation, testing and commissioning, as well as the maintenance of wastewater inlet works and equipment such as hand raked screens, hand stops and open channel sluices, grit channels, as well as flow measurement sensors and converter devices.

This specification shall form an integral part of the repair and maintenance contract document and shall be read in conjunction with portion 3: Additional Specifications included in this document.

This specification shall act as a guideline to the Particular Specification and, in the event of any discrepancies between the Technical Specification and the Particular Specification, the latter shall take precedence.

The Contractor shall also be responsible to manage and maintain the wastewater inlet works in accordance with the prescriptions in this specification. The repair work and maintenance of the particular wastewater inlet works are specified in the relevant clauses on detail of repair work and maintenance in this specification.

EA 02 STANDARD SPECIFICATIONS

EA 02.01 GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES

The latest edition, including all amendments up to date of tender, of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

SANS 1200 - Standardized specification for civil engineering construction

EA 02.02 OTHER SPECIFICATIONS

NA

EA 02.03 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act, 1993 (Act no 85 of 1993) shall be adhered to.

EA 02.04 MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

EA 02.05 MUNICIPAL REGULATIONS, LAWS AND BY-LAWS

All municipal regulations, laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

EA 03 ADDITIONAL REQUIREMENTS FOR REPAIR AND INSTALLATION OF WASTEWATER INLET WORKS EQUIPMENT

EA 03.01 FLOW MEASUREMENT REQUIREMENTS

The inlet works has ben provided with an Ultra-sonic flow meter and a Parshall flume in the channel upstream of the biological reactor.

The Contractor shall ensure that:

(a) The installation of the level sensor conforms to the specifications of the flume;
(b) The flow meter is calibrated correctly; and
(c) The data logging of the instrument is functional. The data logger shall store the following information:
  (i) Average hourly flows for every hour of the day (l/s);
  (ii) Maximum flow for every hour of the day (l/s);
  (iii) Minimum flow for every hour of the day (l/s);
  (iv) Average daily flow (l/s);
  (v) Total volume of wastewater measured (kl/d).

  If the existing equipment cannot store the data, it shall be replaced with a suitable instrument.

EA 03.03 REQUIREMENTS FOR HAND RAKED SCREENS

The existing screen is a hand-raked screen with an aperture of approximately 20 mm. The "bucket" into which the screenings are raked is not effective as the screenings can drop back into the channel. The installation needs to be modified to reduce the aperture by installing a 3 mm thick stainless steel plate (SS304) with 10 mm draining holes onto which the screenings can be raked.

The plate shall be designed by the contractor to ensure efficient draining of the screenings.

EA 03.04 REQUIREMENTS FOR RAG CATCHER

A rag catcher is installed downstream of the flow measuring installation. In this location, the flow measurement is obstructed whenever the rag catcher is blocked.

It is a requirement that the rag catcher be removed from the current location to be installed approximately 2 m downstream of the degritting channels as indicated by the Engineer. If the existing rag catcher cannot be removed and reinstalled, then it needs to be removed and the replaced in the new location with a new rag catcher of similar design.

EA 04 OPERATING AND MAINTENANCE MANUALS

The Contractor shall at the start of the Contract be given all available as-built information and operating and maintenance manuals.

The Contractor shall be responsible for the compilation of an inventory list and operating and maintenance manuals.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance Manuals.

EA 05 DETAIL OF REPAIR WORK

EA 05.01 GENERAL

The Engineer will demarcate any areas to be repaired and shall instruct the Contractor with regard to the repair work to be done.

EA 05.02 INLET WORKS

Repair work to the inlet sump, screen chambers and grit channels shall include the following:

Beitbridge Port of Entry:

(a) Check, and move flow meter sensor;
(b) Provide data logger
(c) Provide drain plate for screenings
(d) Move or move and replace rag catcher

EA 06 MAINTENANCE

EA 06.01 GENERAL

Maintenance shall include all repair work, replacing of components, routine setting, fixing of leaks, general corrosion protection or any other actions or rectifying measures necessary for complete operation of wastewater works. Routine preventative maintenance according to the manufacturer's specification as set out in the operating and maintenance manual, as well as unforeseen repair work or replacement, shall be carried out.

Remuneration for maintenance of the complete wastewater inlet works shall be deemed included in ten points for the tendered rate for monthly payment of maintenance of the installation of which it forms part.

EA 06.02 ROUTINE PREVENTATIVE MAINTENANCE

This routine maintenance of the installations, systems and equipment shall be done in accordance with Additional Specification SA: General Maintenance and the Particular Specification related to this work.

The routine maintenance work to be performed and executed shall include, but not be limited to the items listed in table EA 06.02/1 below.

These actions and findings shall be logged and reported on the relevant approved schedules and reports.

TABLE EA 06.02/1

NO	ROUTINE PREVENTATIVE MAINTENANCE OF INLET WORKS	MAINTENANCE FREQUENCY
1	Check and lubricate sluice guide rails.	Monthly
2	Clean and calibrate flow rate measurement device	Monthly

EA 06.03 FLOW RATE MEASUREMENT

The Contractor shall be responsible for the proper performance of flow measurement devices. To ensure a perfect functional condition, the flow measuring devices shall be cleaned and calibrated monthly. The measuring devices shall be calibrated regularly by a manufacturer's representative according to his specification. Apart from regular calibration, the Contractor shall keep records of flow measurements to establish base line data that will be used for future monitoring and periodic maintenance calibration.

EA 07 MEASUREMENT AND PAYMENT

EA.07.01 SERVICE FLOW METER ..... Unit: Lump sum

The unit of measurement shall be the Lump Sum.

The tendered rates shall include full compensation for all work required for the service and possible re-installation of the flow sensor including the design, manufacture, corrosion protection, patent rights, pre-delivery testing and test certificates, transport for delivery to site and off-loading and installation, including all handling of the equipment of any equipment required for the installation.

EA.07.02 SUPPLY AND DELIVERY OF FLOW METER AND DATA LOGGER..... Unit: number

The unit of measurement shall be the number of specified units of data logging equipment supplied and delivered.
The tendered rates shall include full compensation for the design, building of parshall flume structure, manufacture, corrosion
protection, patent rights, pre-delivery testing and test certificates, transport for delivery to site and off-loading, including all handling of the equipment.

EA.07.03 SUPPLY AND INSTALLATION, TESTING AND COMMISSIONING OF SCREENINGS DRAINING PLATE..... Unit : number

The unit of measurement shall be the number of plates supplied, installed and commissioned.

The tendered rates shall include full compensation for the site handling and positioning of the equipment, including the fastening of the equipment in its designated position. The following shall also be included in the tendered rates:

(a) Installation of the screening draining plate;
(b) All required installation materials, labour and consumables to render a complete and working installation.

EA.07.04 **DECOMMISSIONING AND REMOVAL OF RAG CATCHER**..... Unit : Lump Sum

The unit of measurement shall be the Lump Sum.

The tendered rates shall include full compensation for all labour, machinery, tools, transport and site handling necessary for the decommissioning and removal equipment.

EA.07.05 **SUPPLY AND INSTALLATION OF A NEW RAG-CATCHER** ..... Unit : Lump Sum

The unit of measurement shall be the Lump Sum.

The tendered rates shall include full compensation for all components, materials, tools, transport, site handling and labour necessary for the design, manufacture, supply and delivery to site, installation and commissioning of a new rag-catcher.

EA.07.06 **DESIGN AND ERECTION OF FLOW METER STRUCTURE.....Unit: Lump sum**

The unit of measurement shall be the Lump Sum.

The tendered rates shall include full compensation for all components, design, erection materials, tools, transport, site handling and labour necessary for the design, manufacture, supply and delivery to site, installation and commissioning of the structure (e.g. Parshall Flume).

TECHNICAL SPECIFICATION

EB: WASTEWATER PUMP SYSTEMS

CONTENTS

EB 01 SCOPE

This section covers the decommissioning, removal, repair and reconditioning, installation, testing, commissioning and maintenance of pumping equipment, aerators, motor control devices and low voltage cables.

All pumping equipment appeared to be in a good working condition at the time of the inspection, and this specification is provided for the event that a pump needs to be replaced.

EB 02 STANDARDS

This specification shall be read in conjunction with the following specifications:

BS 5316, Part 1:	Acceptance tests for centrifugal, mixed flow and axial pumps.
SABS 948	Three-Phase induction motors
SABS 1222	Enclosures for electrical equipment (classified according to the degree of protection that the enclosure provides)
BS 4999	General requirements for rotating electrical machines
BS 1486: Part 2	Heavy duty lubrication nipples
ISO 281/1	Rolling bearings – dynamic load ratings and rating life

EB 03 PUMP DESIGN AND REQUIREMENTS

(a) Submersible pumps shall be designed to be suitable for submersion in sewage up to a depth of 5 m.

(b) The pump shaft shall be manufactured from stainless steel and shall be sealed where it enters the casing with double mechanical face seals.

(c) The impeller shall be suitable for pumping a type of wastewater as specified in EB 7: Detail of work. All impellers shall be of the non-clogging type. The spacer

between the impeller and backplate shall be reset every six months to the minimum distance to prevent clogging of rags between impeller and backplate.

(d) The impeller shall be manufactured from stainless steel or, in the case of other materials, it shall be coated with an approved material resistant to abrasion and corrosion due to the environment specified. For pumps rated below 2 kW, non-metallic impellers may be utilised.

(e) The impeller shall be statically, dynamically and hydraulically balanced. No holes may be drilled in the impeller to balance it with regard to mass distribution.

(f) Only permanently sealed ball or roller bearings shall be installed.

(g) Bearings shall have a B-10 life rating of 100 000 hours.

(h) The pump shall be a currently catalogued product.

(i) Performance curves shall be based on a reproducible and certified test carried out in an approved testing facility, such as the SABS.

(j) The flow rate at break-off point of the curve for the impeller selected shall be at least 1,5 times that of the maximum flow rate specified.

(k) The head at zero delivery of the curve from the impeller selected shall be at least 1,2 times the maximum head in the pump's operational range.

(l) Each submersible pump shall be clearly labelled. The label shall be a 0,5 mm thick stainless steel plate of dimensions 100 mm x 50 mm. The label shall be fixed to the pump exterior with an approved adhesive or other method over its full back surface after the completion of corrosion protection on the pump. It may follow the shape of the pump exterior over areas suited for the bending of flat surfaces excluding sharp folds. Under no circumstances shall the label plate influence, damage or otherwise have other detrimental effects on the corrosion protection system. Information included on the label shall be: pump rates, pump head, power required, NPSH (r) rotational speed and impeller detail.

(m) All new submersible pumps shall be supplied with a length of power cable to suit the installation shown on the drawings.

(n) All new pumps utilised for the pumping of biological sludges shall be fitted with double flushed mechanical seals, which shall be included in the cost of the pumps. The pump shafts shall be hardened and accurately ground where the seal bears on the shaft. The rotating seal face shall be mounted on a flexible member sealing on the shaft as well. The flexible member shall be manufactured from rubber, PTFE or equivalent material suitable for the operating environment.

EB 04 MOTOR DESIGN AND REQUIREMENTS

(a) Electric motors shall comply with the requirements of SABS 948

(b) Imported motors forming an integral part of the pump shall be submitted to the South African Bureau of Standards to be tested in accordance with the requirements of SABS 948.

(c) All motors shall be standard catalogue models and shall be readily available.

(d) All motors shall, where possible, be from the same manufacturer and shall have the same interchangeable frames. Variations in type and size shall, where possible, be limited to prevent stocking a variety of special spares.

(e) All motors shall have dynamically balanced rotors supported by maintenance-free, sealed-for-life ball bearings.

(f) All motors shall be suitably coated to ensure the satisfactory operation of the motor under the specified class of service.

(g) All terminal boxes shall be waterproof and suited for submersion up to the depth as specified for the pumps.

(h) An adequate length of waterproof cable, purpose-made for submerging, shall be supplied with each submersible motor. The coupling of this cable to the normal power-distribution cable, which usually is of the PVC type with steel-wire armour, shall be placed at least 1,0 m above the maximum water level by means of a purpose-made, weatherproof, outdoor junction box. The submerged cable shall be supported to minimise any movement of the cable, which result from turbulence caused by the operation of the equipment or the flow of the water.

(i) Thermistor protection or Klixon type temperature switches shall be provided for submersible motors.

(j) Seal monitors shall be provided for submersible motors, together with the required seal monitor relays. The cost for the seal monitor relays shall be deemed to be included in the rated tendered for the equipment.

EB 05 WORKING VOLTAGE AND SUPPLY SYSTEMS

The motors shall be capable of operating within ±10% of the nominal supply voltage without risk of damage. All motors shall be suitable for operating continuously at the specified 3-phase voltage system under actual service conditions, including the ±10% voltage tolerance, without exceeding the specified temperature rise determined by the resistance on a basic full load heat run.

All motors shall be capable of operating continuously under actual service conditions at any supply frequency between 48 and 51 Hz together with any voltage between ± 5% of the nominal supply voltage.
The slip-in speed of any motor at 80% of the nominal voltage at 50 Hz shall not exceed a percentage agreed on by the Engineer, and the motors shall be capable of operating at this voltage for a period of five minutes without deleterious heating.

EB 06 PROTECTION AND CONTROL DEVICES

Submersible pumping equipment shall have float switches to switch the pump motor on and off, according to the level of the liquid. Switches shall operate freely and switch, not be hindered by cables or other switches and shall switch off at a level where no damage to the pump or motor will occur.

Three level switches shall operate a pump control system:

(a) Level switch one shall switch off pumps at low level.

(b) Level switch two shall switch on one pump at an intermediate level, to draw the liquid down to level 1. When the level again rises to where level switch two is switched on, the pump duty shall rotate to start the motor parallel to the one running the first time.

(c) Level switch three shall switch on both pumps to run in parallel at a high level.

(d) In the event of a pump failing to start, the other pump must automatically be restarted.

(e) Pumps shall be operated in both manual and automatic modes.

EB 07 STANDARD MOTOR CONTROL CENTRE REQUIREMENTS

The new replacement motor control centre for the water pumps shall be wired to comply with the requirements as set out in this clause.

(a) The motor control centre shall be of the free standing, weatherproof, corrosion resistant

(b) Motor Control Centre panel material must be of 2.0mm thick IP65, 3CR12, coated steel.

(c) The face plate of the motor control centre must be inside the complete panel and the complete panel must have a lockable door, capable of locking with a padlock.

(d) The faceplate of the motor control centre must have a lockable isolator to ensure that the panel if off when the face plate cover is opened.

(e) The power supply cable from the MCC to the pump shall be tested for conformity to be re-used. In the event that the cable might not pass such testing by the Contractor, the Contractor shall inform the Engineer in writing. The Engineer will instruct the Contractor with regard to a new cable to be installed. *Remuneration, in the event of a new power supply cable being required from the MCC to the pump, will be measured under the re-measurable electrical repair quantities and must* ***not*** *be included in the payment item for the replacement and equipping of the Motor Control Centre!*

(f) Provide an engraved label on the door of the MCC with the relevant MCC number on. The label shall be secured with screws and nuts.

(g) The existing level float switches will be tested and replaced if defective.

(h) Switchgear and equipment shall be installed in the MCC to indicate and ensure:

Automatically regulate the start and stop of the pumps
- Indicate the time that the pumps has been operating since commissioning (hour meters)

Start/ stop the pumps manually
- Indicate that the pumps is running
- Indicate that the pumps has tripped
- Indicate Amps for each pump
- Indicate Main Supply Voltage (L1, L2 & L3) & ((L1/L2, L2/L3 & L3/L1) Ensure Phase failure protection

Insulation resistance before start-up
- Temperature (Tempcon, Pt sensor and PTC/thermal switch) Overload/under load
- Overvoltage/under voltage Phase sequence

Power factor
- Power consumption
- Harmonic distortion
- Run and start capacitor (single-phase)
- Operating hours and number of starts
- Lightning and surge protection

(i) Test for correct functioning on completion of electrical repair work including issuing of certificate of compliance.

(j) Emergency stop buttons shall be installed at the pump in weather boxes for emergency stop functions.

EB 08 TESTING AND COMMISSIONING

EB 08.01 TEST TO BE PERFORMED

(a) All pumping equipment shall be subject to the commissioning tests as described in the standard specification on testing and commissioning

(b) At least one of each type or size of pump supplied, repaired or reconditioned, shall be subject to a delivery flow rate test. The Contractor will supply flow rate or volumetric flow testing facilities.

(c) The operating point of each pump shall be determined.

(d) Efficiency tests will be performed.

(e) NPSH tests will be performed.

EB 08.02 PUMP OPERATING POINT

During the day-01 commissioning tests the pump operating point shall be determined by observing the following:

(a) Pump delivery and suction pressures, and
(b) Electric motor power consumption.

If no efficiency tests are required, then the motor power consumption shall be calculated from the voltage and current measurements obtained during the commissioning test.

The Contractor shall supply the necessary adaptors, fittings and pressures gauges to measure the suction and delivery pressures. If no gauge fittings exist on the suction side, then the suction pressure conditions will be calculated from the system properties.

EB 08.03 FLOW RATE (DELIVERY), EFFICIENCY AND NPSH TESTS

(a) Testing will be done in accordance with BS 5316 Part 1, Class C tests.

(b) Power consumption of electric motors shall be as determined by the three Wattmeter method where efficiency tests are required in the detail specification.

EB 08.04 TEST CONDITIONS

(a) All tests will be performed in situ.

(b) The pumped medium or liquid specified as the process liquid in the detail specifications shall be utilised during the tests. The Contractor shall obtain from the pump manufacturer, the test point for clean water corresponding to the specified duty point for the pumped liquid, in order to relate the measured performance to the pump suppliers curves which are based on water.

EB 08.05 ADDITIONAL TESTS

Additional tests may be specified in the detail of work.

EB 09 OPERATING AND MAINTENANCE MANUALS

The contractor shall compile an operating and maintenance manual in accordance with Additional Specification SB: Operating and Maintenance Manuals.

The Operating and Maintenance Manuals shall provide for all new pumps and equipment supplied under this contract.

EB 10 TRAINING OF OPERATING PERSONNEL

The contractor shall be responsible for training of operating personnel who are employed by the Department of Public Works in accordance with additional specification SC: Training. The training course will be based on the Operating and Maintenance Manuals. A programme shall be submitted to the Engineer, and training shall be scheduled upon approval of the Operating and Maintenance Manuals and Training Programme.

The training shall be presented during a minimum of two sessions with a minimum duration of three hours each.

EB 11 MAINTENANCE

EB 11.01 GENERAL

All pumping equipment and systems shall be serviced and repaired, following practical completion of the installation of which it forms part, to maintain it in perfect functional condition.

The Port of Entry as listed below has been previously repaired under Repair and Maintenance Contracts for the Department of Public Works, and the Contractor shall proceed with his Maintenance Responsibilities as listed below at the date of Site Handover.

Maintenance, including routine preventative maintenance according to the manufacturer's specification to be set out in the operating and maintenance manual, as well as unforeseen repair work or replacement, shall be carried out on:

Beitbridge Port of Entry:

The remuneration for monthly preventative and breakdown maintenance of pumping equipment, aerators and systems shall be deemed included in the tendered rate for ten points of the installation of which the system forms part. Installations are specified in Additional specification SA: General Maintenance.

EB 11.02 ROUTINE PREVENTATIVE MAINTENANCE

The routine preventative maintenance work to be carried out shall include but not be limited to the items listed in table EB 10.02/1 below.

These actions and findings shall be logged and reported on the relevant approved schedules and reports.

TABLE EB 10.02/1

NO	ROUTINE PREVENTATIVE MAINTENANCE OF WASTEWATER PUMP SYSTEMS	MAINTENANCE FREQUENCY
1	Visually inspect and report on complete system	Monthly
2	Check, service, repair and clean all pumps	Six-monthly
3	Corrosion protect pumps, motors and surface piping	Six-monthly
4	Check, inspect, report and repair all leaks	Monthly
5	Check and lubricate moving parts	Four-monthly

EB 12 MEASUREMENT AND PAYMENT

EB.12.01 **SUPPLY AND DELIVERY OF PUMPING EQUIPMENT** ..... Unit: number

The unit of measurement shall be the number of pumping equipment/aerators supplied and delivered.

The tendered rates shall include full compensation for the design, manufacture, corrosion protection, patent rights, pre-delivery testing and test certificates, transport for delivery to site and off-loading including all handling of the equipment. The equipment shall include the following:

(a) The pump/aerator and motor as integrated unit
(b) Electrical power cable

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

EB.12.02 **INSTALLATION, TESTING AND COMMISSIONING OF PUMPING EQUIPMENT** ..... Unit: number

The unit of measurement shall be the number of pumping equipment/aerators tested and commissioned.

The tendered rates shall include full compensation for the site handling and positioning of the pumping equipment/aerators including the fastening of the equipment in its designated position. The following shall also be included in the tendered rates:

(a) Installation of the guide rails and sealing frame.
(b) Coupling of all required pipes flanges, including all required gaskets, nuts, bolts and washers.
(c) Routing and fastening of the power cable up to the isolator box.
(d) All required installation materials, labour and consumables to render a complete and working installation.

The tendered rates shall also include full compensation for all preliminary tests, delivery and efficiency tests if required and commissioning tests. Commissioning tests shall comply with the section dealing with testing and commissioning.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

EB.12.03 **DECOMMISSIONING AND REMOVAL OF PUMPING EQUIPMENT** ..... Unit: number

The unit of measurement shall be the number of pumping equipment/aerators removed and decommissioned.

The tendered rates shall include full compensation for all labour, machinery, tools, transport and site handling necessary for the decommissioning and removal of submersible pumping equipment.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

EB. 12.04 **RECONDITIONING OF PUMPING EQUIPMENT** Unit: number

The unit of measurement shall be the number of pumps and motors/aerators including motors reconditioned.

The tendered rates shall include full compensation for replacement of components and materials and for, tools, transport, site handling and labour necessary for the complete reconditioning of pumping equipment/aerators to conform to all the specifications in EB 03: Pump design and requirements and EB 04: Motor design and requirements.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

EB. 12.05 **REPAIR OF PUMPING EQUIPMENT**..... Unit: number

The unit of measurement shall be the number of pumps and motors/aerators including motors repaired.
The tendered rate shall include full compensation for supply of an identification label, resetting the spacer between impeller and backplate and ensuring that impeller rotates freely as well as cleaning and corrosion protection and installing a new hoisting chain.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

EB. 12.06 **SERVICING OF PUMPING EQUIPMENT**..... Unit: number

The unit of measurement shall be the number of pumps or aerators serviced. The tendered rate shall include full compensation for servicing (including all consumables), cleaning, corrosion protection (including pump and motor base), adjusting, aligning, including disassembling and re-assembling. The tendered rate shall include all labour, tools, equipment and spare parts that form part of servicing as set out in the operating and maintenance manuals or as specified by the supplier.

EB. 12.07 **REPLACE, TEST AND COMMISSIONING OF FLOAT LEVEL SWITCHES OR OTHER LEVEL PROBES**..... Unit: number

The unit of measurement shall be the number of level switches or probes replaced.

The tendered rates shall include full compensation for replacement of components and materials and for tools, transport, site handling and labour necessary for the complete reconditioning of all components of the level control devices

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

EB. 12.08 **PUMPING OUT, CLEANING AND RECONDITIONING OF WASTE WATER PUMP SUMPS AND RELATED INFRASTRUCTURE**..... ....Unit: number

The unit of measurement shall be the number of waste water pump sumps and related infrastructure cleaned and reconditioned as described in.

The tendered rates shall include full compensation for all components, materials, tools, transport, site handling and labour necessary for the complete cleaning and reconditioning of wastewater pump sumps and related infrastructure.

EB. 12.09 **RECONDITIONING OF MCC BOARDS OR OTHER ELECTRICITY BOARDS**..... Unit: number

The unit of measurement shall be the number of MCC boards or other electricity boards reconditioned/serviced.

The tendered rates shall include full compensation for replacement of components and materials and for tools, transport, site handling and labour necessary for the complete reconditioning of all components of the board.

The tendered rate shall further include full compensation for the cleaning and opening of MCC or kiosk, vermin protection, checking of MCB's, checking and tightening of wire terminations, fitting of labels and blank covers.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

EB. 12.10 **REPLACE MCC ENCLOSURE** ..... Unit: number

The unit of measurement shall be the number of MCC boards enclosures replaced

The tendered rates shall include full compensation for the manufacturing, delivery and installation of the new 316 stainless steel enclosure including testing and commissioning of the MCC panel.

The tendered rate shall further include for the disconnecting, removal of all the electrical equipment and cabling from the old enclosure and the installation of all the equipment removed in to the new enclosure including all associated wiring, cable terminations and testing and commissioning of the MCC panel

EB. 12.11 **SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF MCC BOARDS OR OTHER ELECTRICITY BOARDS**..... Unit: number

The unit of measurement shall be the number of MCC boards or other electricity boards supplied of existing boards reconditioned.

The tendered rates shall include full compensation for supply of components and materials and for tools, transport, site handling and labour necessary for the complete installation of the board or supply of all components to provide a fully functional MCC board.

The tendered rates shall also include full compensation for all preliminary tests, delivery and efficiency tests if required and commissioning tests. Commissioning tests shall comply with the section dealing with testing and commissioning.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

EB. 12.12 **SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF MECHANICAL EQUIPMENT**..... Unit: PC Sum

The unit of measurement shall be the number of the specified type of mechanical equipment supplied, delivered to site, installed, tested and commissioned.

The tendered rates shall include full compensation for supply of components and materials and for tools, transport, site handling and labour necessary for the complete installation of the board or supply of all components to provide a fully functional MCC board.

The tendered rates shall also include full compensation for all preliminary tests, delivery and efficiency tests if required and commissioning tests. Commissioning tests shall comply with the section dealing with testing and commissioning.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

EB. 12.13 **DECOMMISSIONING, SERVICING, TESTING, RECOMMISSIONING AND CALIBRATION OF EXISTING FLOW MEASURING EQUIPMENT**..... Unit: number

The unit of measurement shall be the number of flow meters serviced and repaird.

The tendered rates shall include full compensation for replacement of components and materials and for tools, transport, site handling and labour necessary for the complete reconditioning of all components of the flow meters.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

TECHNICAL SPECIFICATION

EC: SEDIMENTATION TANKS

CONTENTS

EC 01 SCOPE

Sedimentation tanks include all primary settling tanks and secondary settling tanks (also referred to as final clarifiers or humus tanks, where sedimentation tanks are downstream of biological trickling filters). The repair work and maintenance responsibilities of sedimentation tanks shall form part of the whole of a wastewater treatment works.

Types of settling phenomena likely to occur in sedimentation tanks include:

(1) Discrete particle settling, such as sand and grit;
(2) Flocculant settling, such as suspended solids in untreated water in primary settling tanks;
(3) Zone settling, such as sludge blankets in secondary settling tanks;
(4) Compression settling, such as the lower layers of a deep sludge mass.

The function of the primary sedimentation tanks is the reduction in organic load entering the biological treatment facility. The reduction in organic load is achieved as a result of solid material (raw sludge) settling under the influence of gravity. Raw sludge shall be withdrawn to sludge treatment and disposal works.

The function of secondary settling tanks is to ensure a clear effluent with the specified solids content, as well as return of activated sludge to a biological reactor, or withdrawal of humus where the sedimentation tank is downstream of a biological trickling filter. Activated sludge return and humus withdrawal systems are included in the work and responsibilities described in this specification.

The maintenance of sedimentation tanks shall include various responsibilities, as specified in the relevant clauses. Maintenance responsibilities shall include all work to ensure the functional performance of sedimentation tanks and to maintain the specified quality of effluent.

This specification shall form an integral part of the repair and maintenance contract document and shall be read in conjunction with portion 3: Additional Specifications included in this document.

This specification shall act as a guideline to the Particular Specification and, in the event of any discrepancies between the Technical Specification and the Particular Specification, the latter shall take precedence.

EC 02 STANDARD SPECIFICATIONS AND ADDITIONAL SPECIFICATIONS

The latest edition, including all amendments up to date of tender, of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

EC 02.01 GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES

SANS 1200 Standardized specification for civil engineering construction

SANS 6049 Water - suspended solids content, second edition, 1990

Operating manual for biological nutrient removal wastewater treatment works, WRC Report no TT83/97, 1997

Theory, design and operation of nutrient removal activated sludge processes, WRC Report no 15525, 1984

EC 02.02 OTHER SPECIFICATIONS

EB Wastewater pump systems
EE Activated Sludge Works
EF Sludge treatment and disposal

EC 02.03 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act of 1993: Construction Regulations, 2003 as promulgated in Government Gazette No 25207 and Regulation Gazette No 7721 of 18 July 2003 shall be adhered to.

EC 02.04 MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

EC 02.05 MUNICIPAL REGULATIONS, LAWS AND BY-LAWS

All municipal regulations laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

EC 03 ADDITIONAL REQUIREMENTS FOR REPAIR AND RECOMMISSIONING OF SEDIMENTATION TANKS AND APPURTENANCES

EC 03.01 GENERAL

Sedimentation tanks shall be repaired to the level of designed functionality or to comply with requirements of laws and regulations. The repair work shall enable the Contractor to maintain the units as new units for the period as specified.

EC 03.02 FIXED BRIDGES

Fixed bridges shall be repaired allowing safe access to the centre of sedimentation tanks. Bridges shall be repaired to comply with the Occupational Health and Safety Act 85 of 1993.

Bridge repair shall imply removal thereof to complete repair work where specified. Repair work shall include sanding and painting of metal to yield a finish protected against corrosion. Hand railings and walkways shall be cleaned, corrosion protected, fixed and replaced in part where necessary.

Access for cleaning of stilling wells shall not be impaired as a consequence of repair work.

EC 03.03 INLET PIPEWORK AND VALVES

Repair of inlet pipework shall include all lengths of pipe between the previous process unit and the centre stilling well outlet. Pipework shall be repaired where sedimentation tanks are taken out of commission and flow bypassed through parallel units or bypassed to other process units.

Repair work shall include fixing and/or replacement of lengths of pipe, brackets and hangers and all appurtenances, as detailed on the drawings.

EC 03.04 STILLING WELLS

Stilling wells shall be removed together with the fixed bridge and repaired with a finish to protect the stilling well against corrosion. The diameter, material and method of fixing shall be as detailed on drawings.

EC 03.05 EFFLUENT WEIRS

Where specified, effluent weirs shall be removed and reinstalled horizontally, within tolerance, to ensure equal flow distribution through the sedimentation tank. The weirs shall be sanded and painted against corrosion before reinstallation.

EC 03.06 EFFLUENT LAUNDERS AND PERIMETER WALLS

All cracks in effluent launders shall be sealed and all algae removed from surface. The Contractor shall make temporary arrangements to accommodate the existing flow during repair work. The walls of the launder (on the perimeter of the tank) channel shall be repaired where necessary. All hand railings, cemented tiles or other barriers on the perimeter and on top of walls shall be cemented, repaired and painted.

EC 03.07 SCUM WITHDRAWAL SYSTEMS

Scum withdrawal systems at primary settling tanks shall be repaired together with the central stilling well. From the central stilling well an open chute (half pipe) shall run radially to the scum baffle. From the scum baffle the full pipe shall run to the outside of the tank to remove scum. A valve shall be connected to the far end of the pipe and will open into a scum/sludge manhole. A straining basket or screen at the open end of the valve (pipe end) shall intercept all artificial solids present in scum. A scum baffle (scum board) shall prevent scum from escaping the sedimentation tank. The circular scum baffle shall run around the sedimentation tank 300 - 400 mm from the inside of the effluent weir. The scum baffle shall be 450 - 500 mm high and submerged by at least 400 mm of its height.

Repair work shall include replacement, repair, cleaning and corrosion protection of the outlet chute; pipeline and scum baffle to form a perfect working system.

EC 03.08 PRIMARY SETTLING TANKS

Not applicable

EC 03.09 SLUDGE WITHDRAWAL SYSTEM (PRIMARY SETTLING TANKS)

Not applicable

EC 03.10 SECONDARY SETTLING TANKS

Where parallel tanks are used, both tanks shall be emptied and cleaned completely. The Contractor shall isolate one tank and divert all flow to other tank(s) to do repair work, which shall include cleaning of pipelines entering the sedimentation tank, desludging all components/parts of the sedimentation tank and repairing cracks and waterproofing.

Where single tanks are used the tank shall be decommissioned and adequate provision shall be made for temporary treatment and disposal.

EC 03.11 ACTIVATED SLUDGE RETURN WITHDRAWAL SYSTEMS

The sludge return withdrawal system shall consist of a pipeline and manually opened gate valve running into a sludge pump sump. The repair work shall include removing the valve, while isolating the outlet pipe by means of a flanged spade and blank flange. The gate valve shall be fully reconditioned.

The sludge return withdrawal shall be executed by means of submersible pumps. Submersible pumps shall be reconditioned where specified in accordance with the requirements of Technical Specification EB: Wastewater pump systems. The electrical supply and motor control of submersible pumps shall be repaired with the pump where specified in accordance with the requirements of the relevant technical specifications.

Submersible pumps shall be switched on when a level float switch reaches a certain fixed level (medium height) in the sump. Pumps shall be stopped at a certain low level. When the same medium level is reached again, the next pump shall be switched on (duty rotation). When a still higher level is reached, a level float switch shall cause both pumps to run simultaneously in parallel (high flow conditions).

EC 03.12 RECOMMISSIONING OF SEDIMENTATION TANKS

Sedimentation tanks shall be recommissioned on completion of repair work by allowing them to fill with natural flow. Initial sludge carry-over must be reduced by bringing the system into function, as described, as quickly as possible. Correct functioning must be achieved within 24 hours. A continuous low flow withdrawal of sludge (thin sludge) during commissioning, that establishes downflow, may aid in commissioning sedimentation tanks.

EC 04 OPERATING AND MAINTENANCE MANUALS

The Contractor shall at the start of the Contract be given all available as-built information and operating and maintenance manuals.

The Contractor shall be responsible for the compilation of an inventory list and operating and maintenance manuals.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance manuals.

EC 05 DETAIL OF REPAIR WORK

EC 05.01 GENERAL

The Contractor shall investigate and inspect all areas of the installation to confirm the extent of the repair work required and shall report to the Engineer. The Engineer will thereafter demarcate any areas to be repaired and shall instruct the Contractor with regard to the repair work to be done.

EC 06 MAINTENANCE OF SEDIMENTATION TANKS

EC 06.01 GENERAL

The maintenance requirements specified in the clauses below shall be the minimum requirements and shall not in any way indemnify the Contractor from maintaining the entire installation in a perfect functional condition.

Maintenance shall include any repair work, cleaning of all components, corrosion protection, replacing of disfunctional components and materials, routine setting, fixing of leaks, or any other actions or rectifying measures necessary to ensure perfect operation of sedimentation tanks according to the functional specification thereof.

The Contractor shall be responsible to compile a database of information containing all test results, including his own tests to ensure correct functioning of the system, with operating conditions, to aid in improving future operation of the plant.

Remuneration for monthly maintenance of all sedimentation tanks shall be deemed included with the tendered rate for ten maintenance points of the installation of which sedimentation tanks form part.

EC 06.02 STATIC BRIDGES

Bridges of both primary and secondary settling tanks shall be maintained clean and protected against corrosion. The bridges shall be maintained safe to enable work and inspections.

EC 06.03 INLET PIPEWORK

Inlet pipework shall be kept open and functional at all times. Pipes shall be cleaned and deblocked when necessary. Pipework shall be maintained leak-free at all times.

Screens shall be cleaned regularly and the debris disposed of.

EC 06.04 STILLING WELLS

Stilling wells shall be kept clean on a daily basis as often as necessary to prevent the build-up of a scum layer of froth and floating debris. Scum shall be removed through the scum withdrawal chute, or manually when necessary.

EC 06.05 EFFLUENT WEIRS

The effluent weirs shall be kept clean and all algae or other growths shall be removed. Floating artificial solids shall be removed and prevented from escaping the sedimentation tank. Artificial solids shall be disposed of with screenings removed at the inlet works. The weirs shall be maintained in perfect functional condition.

EC 06.06 **EFFLUENT/OUTFLOW LAUNDERS**

The effluent launders shall be kept clean and all algae or other growths shall be removed. The launders shall be maintained in perfect functional condition.

EC 06.07 **SCUM WITHDRAWAL AND SCUM WITHDRAWAL SYSTEMS**

Scum shall be withdrawn every three to four hours, or more often when necessary, on a daily basis. A wash water spray system shall produce a concentric flow pattern to collect all scum and floating debris at the outlet chute. Before withdrawal of scum, the collected scum on the water surface shall be sprayed with high-pressure water to cause disintegration of faeces, and to prevent concentrated faeces interception by scum screens. Scum shall be screened on withdrawal and screenings shall be washed to further remove faeces and then disposed of with the screenings collected at the inlet works. Apart from scum withdrawal, the scum collecting in the central stilling well, as well as scum and debris stuck to the scum baffle along the inside perimeter of the sedimentation tank shall be removed manually. The maintenance of sedimentation tanks shall prevent formation of scum layers.

The scum withdrawal system consisting of stilling wells, open chutes, scum baffles, pipelines, valves, screens and wash water spraying nozzles shall be maintained in a perfect functional condition.

EC 06.08 **PRIMARY SETTLING TANKS/BIOLOGICAL REACTOR**

Not applicable.

EC 06.09 **SLUDGE WITHDRAWAL SYSTEM (PRIMARY SETTLING TANKS)**

Not applicable

EC 06.10 **SLUDGE WITHDRAWAL SECONDARY SEDIMENTATION TANKS**

The sludge shall be withdrawn from the Secondary Settling Tank on a continuous basis. It is important that no sludge is stored unnecessarily in the settling tank. The sludge is pumped to the biological reactor to enable treatment of the wastewater.

EC 06.10.01 **Maintenance of secondary sedimentation tanks and appurtenances**

The water-retaining tank structure shall be maintained together with appurtenances such as hand railings, pipework and channels.

EC 06.10.02 **Sludge withdrawal systems**

Sludge withdrawal systems for secondary sedimentation tanks include return activated sludge systems or humus withdrawal systems (humus tanks). Both systems shall be maintained to keep central sludge hoppers, pipework, valves, concrete sumps (water-retaining structures), submersible pumping equipment, electrical control equipment and cables, grating and hand railings in a perfect functional condition.

EC 06.10.03 **Return activated sludge withdrawal rate**

The sludge shall be returned from the secondary settling tank to the biological reactor on a continuous basis regardless of the concentration of the sludge.

EC 06.10.04 **Scum withdrawal**

Secondary settling tank scum, if formation of scum occurs, shall be removed/withdrawn manually by means of a net or pressurised wash water spray.

EC 06.10.05 **Final effluent and testing**

Treated wastewater shall be tested to ensure compliance to regulations as specified. The test samples taken from the secondary sedimentation tanks, shall be tested for suspended solids. The test sample shall be taken from water between the scum baffle and the effluent weir.

EC 06.11 **HUMUS WITHDRAWAL**

Not applicable