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EAST AFRICAN STANDARD

Development, maintenance and management of groundwater resources — Part 2: The design, construction and drilling of boreholes

EAST AFRICAN COMMUNITY

First Edition 2010

Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in East Africa. It is envisaged that through harmonized standardization, trade barriers which are encountered when goods and services are exchanged within the Community will be removed.

In order to meet the above objectives, the EAC Partner States have enacted an East African Standardization, Quality Assurance, Metrology and Test Act, 2006 (EAC SQMT Act, 2006) to make provisions for ensuring standardization, quality assurance, metrology and testing of products produced or originating in a third country and traded in the Community in order to facilitate industrial development and trade as well as helping to protect the health and safety of society and the environment in the Community.

East African Standards are formulated in accordance with the procedures established by the East African Standards Committee. The East African Standards Committee is established under the provisions of Article 4 of the EAC SQMT Act, 2006. The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

Article 15(1) of the EAC SQMT Act, 2006 provides that "Within six months of the declaration of an East African Standard, the Partner States shall adopt, without deviation from the approved text of the standard, the East African Standard as a national standard and withdraw any existing national standard with similar scope and purpose".

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

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Introduction

In the preparation of this East African Standard, the following source was consulted extensively:

SANS 10299-2:2003, *Development, maintenance and management of groundwater resources — Part 2: The design, construction and drilling of boreholes*

Assistance derived from this source and others inadvertently not mentioned is hereby acknowledged.

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Edition 1

SOUTH AFRICAN NATIONAL STANDARD

Development, maintenance and management of groundwater resources

Part 2: The design, construction and drilling of boreholes

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SANS 10299-2:2003
Edition 1

Table of changes

Change No.	Date	Scope

Foreword

This South African standard was approved by National Committee STANSA SC 5120.12B, *Water supply, equipment and systems – Groundwater extraction*, in accordance with procedures of Standards South Africa, in compliance with annex 3 of the WTO/TBT agreement.

Annex A is for information only.

SANS 10299 consists of the following parts, under the general title *Development, maintenance and management of groundwater resources:*

Part 0: *Glossary of terms.*

Part 1: *The location and siting of water boreholes.*

Part 2: *The design, construction and drilling of boreholes.*

Part 4: *Test-pumping of water boreholes.*

Part 5: *The design, selection and performance of pumping equipment for production boreholes.*

Part 6: *The installation and commissioning of pumping equipment for production boreholes.*

Part 7: *The rehabilitation of water boreholes.*

Part 8: *The management of water boreholes.*

Part 9: *The decommissioning of water boreholes.*

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Development, maintenance and management of groundwater resources

Part 2:
The design, construction and drilling of boreholes

1 Scope

This part of SANS 10299 covers the requirements for the design, construction and drilling of machine-drilled boreholes.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of SANS 10299-2. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on SANS 10299-2 are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards can be obtained from Standards South Africa.

ASTM F480, *Standard specification for thermoplastic well casing pipe and couplings made in standard dimension ratios (SDR), SCH 40 and SCH 80.*

BS 879-2, *Water well casing – Part 2: Specification for thermoplastic tubes for casing and slotted casing.*

SANS 241 (SABS 241), *Drinking water.*

SANS 10299-0, *Development, maintenance and management of groundwater resources – Part 0: Glossary of terms.*

SANS 10299-9, *Development, maintenance and management of groundwater resources – Part 9: The decommissioning of water boreholes.*

3 Definitions

For the purposes of this part of SANS 10299, the definitions given in SANS 10299-0 apply.

4 General requirements

Borehole design, drilling and construction is a complex operation and should be done by a competent person. Boreholes intended for commercial abstraction, or to be drilled in aquifers where hydrogeological problems are known to exist, should be designed, drilled and constructed under the

direction of a professional person, in cooperation with the competent person. Deviation from this standard shall be addressed by the professional person in consultation with the competent person.

5 Drilling equipment

5.1 General

The contractor shall supply a drilling rig and equipment which is required for the type of drilling operation to be undertaken.

5.2 Drilling rig and equipment

5.2.1 General

The contractor shall maintain the drilling rig in an efficient working order at all times. The drilling rig and ancillary equipment shall not leak fuel, oil or any fluid, nor have any negative effect on the environment local to the drill site.

5.2.2 Drilling additives

Drilling additives shall:

a) be non-toxic and biodegradable; and

b) not contaminate the aquifer or affect its water quality.

5.2.3 Drill stem

The drilling rig shall be equipped with a range of drill bits, drill rods and drill string stabilizers suitable for the size of hole to be drilled and the type of formations to be drilled through.

6 Development equipment

The contractor shall supply and operate such development equipment, as might be required by the professional or the competent person.

7 Drilling record

7.1 The competent person shall keep, or cause to have kept, a record of information or other such details as agreed. Recorded information shall include the following:

a) Rate of penetration of the drill bit, reported as minutes and seconds per metre of drilling.

b) The size of the drill bit, used during drilling, reported as its nominal diameter in millimetres.

   If the borehole is constructed using different sizes of drill bits, then the depth interval (reported as a depth in metres below ground level) over which each size drill bit was used shall be recorded.

c) The size and type of casing and well screen used in the as-built construction of the borehole. If the as-built construction of the borehole entails more than one size or type of casing (or both) and well screen, then the depth interval (reported as a depth in metres below ground level) over which each size and type occurs in the borehole shall be recorded.

d) The final depth of the borehole reported as a depth in metres below ground level.

e) The depth(s) reported at which water is reported to be encountered during drilling.

f) The final blowout yield of the borehole. This determination shall be made after the borehole has reached its final depth. In order to obtain as accurate a measurement as possible, the method of determination shall be appropriate to the magnitude of the yield.

NOTE If the blowout yield is determined during drilling, then it is possible to establish the individual blowout yield of each successive water occurrence. This will be the difference between the latest and previous measured values.

g) The depth, reported as metres below ground level, of the water rest level in the borehole after its completion. Construction of the borehole is considered to be complete when the drilling machine has moved off the borehole and final finishing of the borehead (as agreed) has been effected. The water level measurement should preferably be made shortly before leaving the site in order to allow the water level to have returned as close as possible to its rest level by the time of measurement. The water level measurement shall be accurate to within 100 mm.

NOTE In instances where the final casing extends above borehole ground level, the measurement may be made from the rim of the casing.

h) Height of the casing above ground level.

i) The date of completion of the borehole.

j) A general description (provided by the competent person) or, when required, a detailed description (provided by the professional person) of the geological formations encountered in the borehole.

7.2 Geological formation samples

The competent person shall collect, or cause to have collected, one sample per metre drilled. The samples shall be laid out in a consistent and orderly fashion. The position of such layout shall be in a safe area away from drilling operations, i.e. out of the way of general site activity and normal pedestrian and vehicular traffic on or across the area of drilling operations.

7.3 Water samples

If the owner requires to know the suitability of the borehole water for its intended use, then it should be agreed that the competent person should collect a sample of water produced from the borehole. The sample should be collected once the borehole has reached its final depth and after flushing and development of the borehole. The water sampling shall be done in accordance with SANS 241.

The suitability of the borehole water for its intended use is determined on the basis of a chemical analysis performed in a water laboratory. The intended water use determines the scope, and therefore also the cost, of the analysis. It shall be agreed to what extent the contractor will assist the owner in obtaining a water analysis.

8 Straightness of production boreholes

8.1 Boreholes shall be sufficiently straight to permit a straight pipe (dummy) of length at least 5 m with a tolerance of ± 0,01 m. The dummy pipe shall have an external diameter of 20 mm less than the internal diameter of the borehole and shall be lowered to the full depth of the borehole.

8.2 This dummy shall be lowered on a cable and fall under its own weight. If the dummy binds at any point before reaching the full depth of the borehole, the borehole shall be deemed to be not acceptably straight.

8.3 In the case of a telescoped borehole, the dummy shall be sized to suit the smallest diameter of the borehole.

8.4 To enhance the straightness of a borehole, stabilizers of a size appropriate to the smallest diameter of the hole being drilled shall be used during drilling operations.

9 Plumbness of production boreholes

9.1 General

The acceptable plumbness of a borehole shall be such that it will not, at any depth, deviate from the vertical through the centre of the hole at the top, to the extent that it adversely affects the equipment to be utilized down the hole (see figure 1).

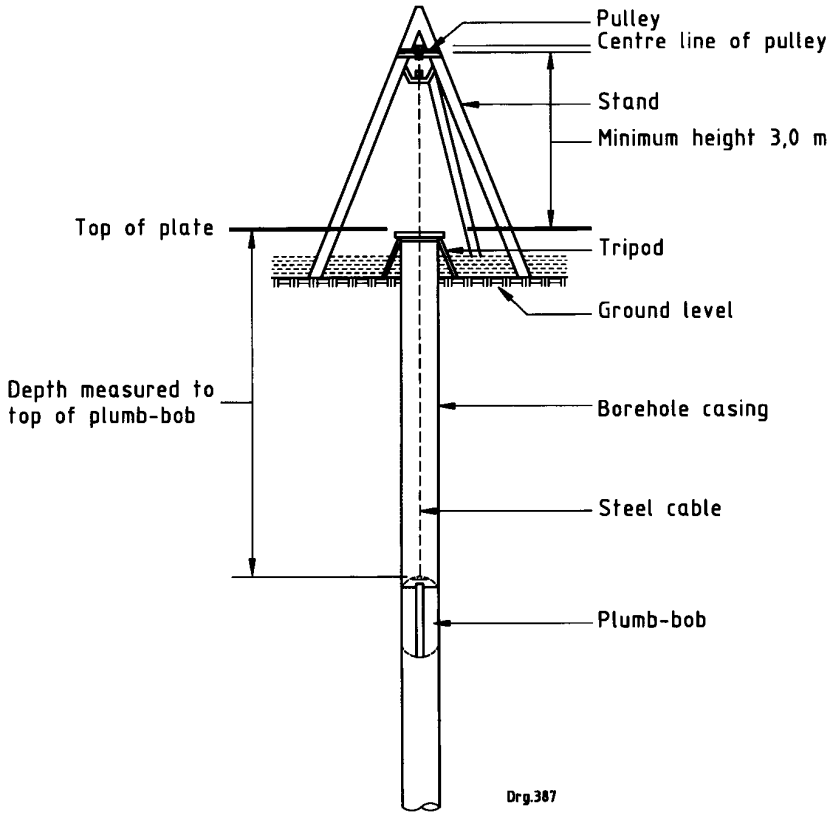

Figure 1 — Plumbness of boreholes

9.2 Determination of verticality of a borehole

To determine the verticality of a borehole, carry out the verticality test as follows:

a) erect the tripod over the borehole such that its apex is above the centre of the borehole;

b) check that the dummy is centrally positioned with a tolerance of ± 3 mm;

c) pass the wire line (steel cable) fitted with a dummy through the pulley mounted at the apex;

d) measure the vertical distance from the pulley to the top of the casing to an accuracy of 0,01 m. The distance shall not be less than 2,4 m;

e) lower the dummy in equal increments down the borehole;

f) measure the deviation of the wire line from the centre of the casing at each depth increment and record the measurements in millimetres;

NOTE The measured deviation of the wire line from the centre of the mouth of the casing at each depth increment indicates the drift (φ) of the dummy.

g) the measured deviation together with a deflection factor (*Df*) to calculate the actual deflection from the borehole at each depth increment according to the following equation:

$$Da = \varphi\ (d + h)/h$$

where

Da is the actual deviation;

φ is the measured drift, in millimetres, of the wire line at a given plumb-bob depth;

d is the depth of the dummy below the casing collar, in metres, for each drift measurement;

h is the vertical distance between the casing collar and the pulley (at the tripod apex) over which the wire line passes, in metres; and

$(d + h)/h$ represents the deflection factor (*Df*).

10 End diameter (bottom diameter)

The finished hole size shall be defined as the diameter at the bottom of the hole.

11 Casing

11.1 Selection of casing

Borehole casings shall be selected to withstand the conditions present within the borehole, i.e. the pressure exerted on the casing by the geological formations and the corrosive nature of the surrounding geological formation and water, the type of aquifer and the intended pump installation.

Steel casings shall have a minimum wall thickness of 3 mm and plastic casings shall have a minimum wall thickness of 6 mm.

11.2 Casing joints

The strength of the jointing shall not be less than 50 % of the mechanical strength of the parent casing material. The jointing shall be capable of supporting the entire weight of the casing string during installation.

11.3 Casing screwed threads

11.3.1 Plastic casing (unplasticised polyvinyl chloride (PVC-u) and polypropylene) shall be threaded in accordance with ASTM F480 or BS 879-2. Solvent welded socket joints shall not be used.

11.3.2 Steel casing should be welded. However, screwed joints of a type deemed acceptable to the competent or professional person could be used. Where a joint requires a connection of two different standards of thread, an adapter should be prefabricated and interconnected in the joint. A socket connection for the jointing of casings is also acceptable.

11.4 Casing installation

11.4.1 General

11.4.1.1 A casing should be installed and grouted across the entire thickness of overburden material resting on bedrock and should extend at least 3 m into hard/fresh bedrock to prevent contamination during and after drilling operations and should be done as specified in 11.4.2 to 11.4.5.

11.4.1.2 A final decision in this regard (see 11.4.1.1) shall rest with the competent person or, when required, the professional person.

11.4.2 Construction casing (temporary casing)

Temporary casing shall be installed in the borehole when drilling under conditions where the possible collapse of loose, broken or weathered formations exist.

11.4.3 Intermediate casing

Intermediate casing shall be installed when necessary to support any broken or fractured zones within the borehole at any depth and when it is intended to reduce hole size. The minimum wall thickness shall be as for production casings. An intermediate casing may be grouted to seal out a contaminated water strike.

11.4.4 Production casing

Production casing shall be installed when it is necessary to prevent the collapse of broken, fractured, friable or weathered formations, or when the use of a well screen or screens is indicated.

11.4.5 Plastic casing

11.4.5.1 Plastic casing (PVC-u or polypropylene) shall, when required by the competent person, be installed and lowered into the borehole under its own weight.

11.4.5.2 Under no circumstances shall the weight of the drilling rig be used to force the casing string into the borehole.

12 Well screens

12.1 General

Well screens shall be fitted in boreholes constructed in unconsolidated or highly fractured or weathered aquifers or where the ingress of aquifer material needs to be controlled.

12.2 Design

12.2.1 Screen open area

The open area of such screening devices should be sufficient to allow the required flow of water to enter at a nominal safe entry velocity (see annex A).

12.2.2 Screen aperture (opening)

Screen aperture should be selected to meet the requirements of the gradation of the sediment or the size of the filter pack to be used and may be one of the following:

a) gravel pack;

b) formation stabilizer; or

c) both.

12.2.3 Types of screens

Depending on the aquifer type, one or a combination of the following types of well screens shall be used:

a) slotted steel casing;

b) preformed thermoplastic screens;

c) wedge wire screens; and

d) precast gravel pack.

12.2.4 Bottom screen or casing sealing

Where a casing or screen is installed and the conditions are such that the possibility exist for material to enter at the bottom of the casing or screen, the casing shall be sealed, for example, by a cement plug installed through a tremie pipe or welded or bolted end-cap.

13 Gravel packing

13.1 General

For the purposes of filtering, the annulus around the screen shall be filled with a material which is appropriate for the intended use (see 13.4).

13.2 Annular space

When used for filter reasons, the annular space shall be a minimum of 76 mm and a maximum of 203 mm.

13.3 Use of centralizers

The casing and screen shall be centralized in the borehole by means of centralizers. Centralizers should be staggered to permit the entry of a tremie pipe and should be placed at a maximum of 6 m intervals.

13.4 Grading, quality and size of material for gravel packs

Gravel packing shall be of a well rounded grain of siliceous rather than calcareous material. Its size shall be uniform and graded to suit the screen aperture and its intended use.

14 Formation stabilizer

Formation stabilizer should be used to fill the annular space between the drilled hole and the casing and to stabilize loose and fractured formation. The material used for the formation stabilizer may be drill cuttings or an aggregate, preferably siliceous rather than calcareous.

15 Sanitary seal

15.1 General

A sanitary seal shall be installed to prevent surface water from entering the borehole, either directly or through the unsaturated zone adjacent to the production casing. Such a sanitary seal shall completely fill the void between the borehole casing and the formation, and shall extend from immediately below the surface collar to a depth, as advised by the competent person, that will prevent contamination of the borehole.

15.2 Bentonite

In order to ensure complete filling of the void between the casing and the borehole, it is advisable to use bentonite pellets or a premixed bentonite slurry below the static water level, and bentonite powder above the static water level.

15.3 Cement grout

Cement grout may be used as a sanitary seal provided that the grout used is of a proven non-shrink type.

NOTE Specialized grout or cement mixed with bentonite may be used.

16 Completed depth of a borehole

The completed depth of a borehole shall include a sump of at least 3 m.

17 Development

Development of the borehole, if required, shall be done by the competent person. Development might include activities such as flushing, hydro-jetting or surging.

18 Well head completion

On completion of the drilling and construction of the borehole, the competent person shall fit a temporary cap to the top of the casing. This cap shall either be welded or bolted to the casing to prevent the ingress of foreign materials into the borehole. This cap shall remain in place until the borehole is equipped for operation.

19 Abandoned boreholes

If a borehole is not completed or is abandoned after completion, the contractor shall decommission the borehole in accordance with the provisions of SANS 10299-9.

20 Acceptance documents

After completion of the borehole, the competent person shall produce acceptance documents for the owner's signature. These documents shall include, *inter alia*, the completed drilling log and details of any development work done to achieve production.

Annex A
(informative)

Typical example of a slotted steel casing

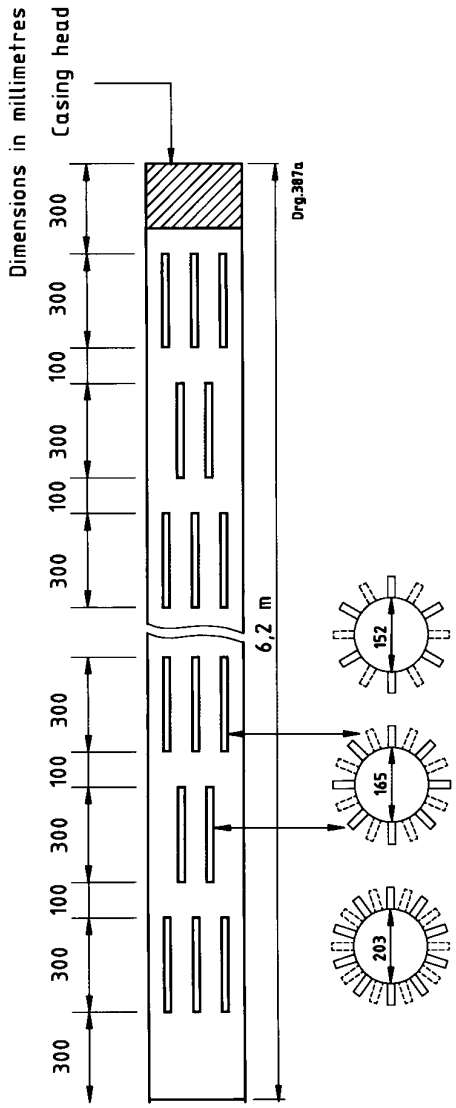

Figure A.1 — Typical example of a perforated or slotted steel casing

Bibliography

BS 879-1, *Water well casing – Part 1: Specification for steel tubes for casing.*

Bibliography

[illegible] Part 1: Specification for steel tubes for casing.