



**MINISTRY OF WATER & ENVIRONMENT**

**WATER SUPPLY AND SANITATION  
PROGRAMME**

**RFP No.: MWE/CONS/16-17/00024/1**

**Technical Specification for  
DRILLING, TEST PUMPING, PUMP INSTALLATION  
AND ASSOCIATED WORKS**

**January 2019**



## **MINISTRY OF WATER & ENVIRONMENT**

**In cooperation with**



**AFRICAN DEVELOPMENT  
BANK GROUP**

**Project ID No. P-UG-E00-012**

### **Technical Specification**

## **Drilling, Test pumping , Pump Installation and Associated Works**

**January 2019**

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## **Technical Specifications**

These technical specifications have been developed to guide the drilling of hand pumps and production boreholes for supplying water to various communities. They are based on various documents for borehole construction. In developing the specifications, different stakeholders, drilling contractors, hydrogeologists and engineers who have experience in the drilling industry have been involved and consulted.

### **1.0 Scope of works**

The work includes drilling boreholes, installation of casings and screens; provision and installation of gravel packing; development of boreholes; test pumping; obtaining water and rock samples; water quality analysis and installation with hand pump or motor driven pumps; as specified hereafter and as directed by the Supervisor.

The contractors must therefore at the end of the contract furnish information on all boreholes constructed to the client including dry wells, or technically failed wells.

### **1.1 Location of the works**

The works are located in communities/rural growth centres/ urban areas of -----  
-----in .....districts. (*List of sites should be attached.*)

### **2.0 Drilling site**

The Contractor shall drill the borehole(s) at the exact location(s) designated by the Employer or the Supervisor and agreed with the local communities or beneficiaries. Tracks required for access of drilling plant, gear, camp and accessories to the borehole site shall be made by the contractor with help of the beneficiary community and the local leaders, and should as little as necessary interfere with existing fences and cultivated land. Borehole locations shall be identified in agreement with the local communities and in Consultation with the Client.

**The table below shows the minimum distances downslope of the borehole that are to be observed.**

<b>Exiting structures</b>	<b>Minimum distance from borehole (m)</b>
Existing public water points ( well/borehole)	500
Other existing waterwell or boreholes	500
Latrines/Septic tank/Soak way	30
Streams, irrigation ditches	20
Buildings	10
Approved or informal soil waste dump , burial ground, lubricant depot	500

*“It should be noted that boreholes used for hand pump water supplies could be at smaller distances from a hydrogeological sustainability point of view.”*

### **3.0 Environmental protection of the site**

Care must be taken in the handling and storage of drilling fluids, oils, greases and fuel to avoid introducing environmental contaminants and pollutants. The Contractor shall dispose of any toxic materials including drilling fluids, cuttings and discharged waters in a manner approved by the Client and so as not to contaminate/pollute public and private property. The Contractor shall adhere to the set of **“Environmental Guidelines and Code of Conduct”** issued to him by the Employer. The Contractor shall ensure that all their personnel are aware of Environmental protection requirements. The Contractor’s adherence to these guidelines will be closely monitored by the Supervisor, and any infringement by the Contractor may render unacceptable the particular portion of the Works to which it applies.

### **4.0 Materials for the works and workmanship**

All materials that will form part of the complete works must be supplied new and used as specified in the technical specifications for the works. Materials must comply with the minimum specifications in the relevant codes. Materials not specified in the technical specifications and which also do not comply with the minimum specifications in the relevant codes of practice shall not be used. Where a national standard does not exist for the material, the relevant British Standard shall apply.

The Contractor is expected to carry out all works as specified and in a professional manner, up to the best professional standards. The Contractor shall carry out operations with due efficiency and dispatch in accordance with the terms of the contract and to the satisfaction of the Client. The Contractor shall use suitable equipment, supply efficient and experienced staff.

- a) The Contractor will provide an experienced project Coordinator to oversee the drilling to be carried out under this Contract.
- b) The Contractor will maintain a full crew on each drilling unit and pump test unit with the necessary training, skills and experience to effectively and efficiently carrying out the contract.
- c) If the Client is dissatisfied with the performance of a member of the crew, such member shall be informed of their shortcomings and warned by the Client's representative/supervisor. If no change results within a reasonable period, the Contractor will be notified and requested to take necessary measures on the unsatisfactory crew member.

## **5.0 Contractor to provide all equipment for the works**

All necessary machinery, equipment and materials to carry out the drilling, test pumping, headwork construction shall be provided by the contractor. The Contractor shall specify the equipment type and capacity that is to be used to undertake the drilling works. Its capacity shall be sufficient to cope with the Works as stated in the Contract. It shall at all times be kept in full working order and goodrepair.

Test pumping equipment shall be independent from the drilling rig(s). Prior to mobilization the Client shall verify the specifications and state of repair of all major items of plant and transport, and shall have the right to order the removal and/or replacement of any items which in his opinion are insufficient or in unsatisfactory condition. Acceptance by the Client or his representative of the Contractor's proposed plant and transport does not relieve the contractor of his obligations.



**Equipment and materials for borehole construction**

In cases where the plant and transport accepted by the Client fails to successfully complete the required works, the Client shall have the right to call upon the Contractor to put such equipment in good order within seven days; or alternatively to remove such plant and replace it with additional plant or equipment which the Client considers necessary to meet the requirements of the Contract. In the event that this requirement is not satisfied, the Client reserves the right to terminate the Contract immediately. **No extra payment shall be made for the Contractor's change of drilling equipment**, labor or other equipment required to complete the Works specified, nor for any incidentals thereto, the cost being deemed to be included in the schedule of rates. All machinery, equipment and materials to carry out the said Works shall be handled, transported and stored in accordance with the manufacturers' recommendations to minimise deterioration.

## **6.0 Supervision of the works**

The execution of the Works is supervised by the Client or Client's appointed Supervisor as named in the Contract Data. The supervisor / supervising hydrogeologist in most cases will also be responsible for geological survey and borehole siting. This hydrogeologist will also be duly registered and a holder of a valid license issued by Ministry of Water and Environment.

## **7.0 Drilling method**

The preferred method of drilling in consolidated compact formations is direct or reverse circulation rotary and down-the-hole hammer drilling techniques, using an appropriate (*biodegradable*) drilling fluid. Boreholes will be drilled with 5/6 inch drill bits and reamed to the right size based on the amount of water available and also for lowering temporary casings.

In unconsolidated loose, unstable, collapsing formations, rotary with appropriate drilling stabilizer will be used. In such a case the drilling diameters will be telescopic starting with diameters large enough to lower temporary casing in the upper collapsing formations and continue drilling with a **final minimum diameter of 6 inch bit**.

The drilling fluids and additives shall consist of water, bio-degradable drilling mud, weight materials (*barite or equivalent*), fluid loss control materials, and foam. The selection, supply and use of drilling additives shall be the responsibility of the Contractor. Toxic or dangerous substances that may adversely affect the quality of the water shall not be added to the drilling fluid. The Contractor shall be responsible for maintaining the quality of the drilling fluid to assure the protection of the aquifer and other potential water bearing formations and ensure that good representative samples of the formation material are obtained.

The Contractor may use any motorized drilling technique that will achieve the depth and diameter required of the well, provided that the techniques used are those specified in his proposal and approved by the Client. The rig to be deployed must be capable of drilling to at least a depth of

25% beyond the anticipated final depth at the required diameter. If the Contractor wishes to cease drilling at a shallower depth and complete the borehole at this depth, he must first get the approval of the Client or his representative. This approval will be provided in writing and will be signed by the Client or his representative. If the Contractor is unable to drill to the required depth due to unsuitable or defective drilling equipment and/or inadequate operator competence, the borehole will not be accepted and the Client shall not be held accountable for any costs associated with that particular borehole.

Temporary casing may be installed in the borehole to prevent formation heave or collapse or sloughing. Installation and diameter of any temporary casing required for the construction of the borehole shall be the responsibility of the Contractor. The installations should be in such a way as to meet the contract specifications. The use of bentonite mud, lost circulation agents or any form of plugging material that may ultimately affect the production capacity of the water bearing strata intersected will not be permitted.

## **8.0 Strata sampling and borehole geodata**

While the drilling operation progresses, representative samples (*min. 100 grams*) of strata penetrated shall be collected at intervals of (2) meters or as instructed by the supervisor. In general the strata samples will also be taken at every change in colour, texture, grain size composition, profile and where water or an aquifer is struck. Cutting samples shall be bagged, labeled with borehole depth at time of collection, and stored in a position where they will not be contaminated by site conditions or drilling operations. The Contractor shall supply strong, transparent sample bags and indelible labels as required. The Contractor shall take every possible precaution to guard against sample contamination.

At completion of drilling, the contractor will be required to complete the borehole geo-log with all information describing the properties of the samples, appearances of water and aquifers, rock types and sampling details. The contractor will then complete the borehole log reports / forms and borehole completion reports / forms which shall include test pumping data sheets, water quality test certificates and installation data sheets and hand them over to the client. **The Contractor will also be required to hand to the client complete borehole logs and all information from dry boreholes and boreholes considered unsuccessful as a result of poor water quality or other technical failures**



**Demonstration of Borehole sampling**

## **9.0 Borehole depth and diameter**

The Contractor shall drill to the total depth and at such diameter as will be instructed by the Employer or the Supervisor. No borehole will be acceptable if drilled to a depth and diameter other than that instructed in writing by the Client or his appointed Supervisor. The total depth will depend on the geological formation and yield requirements. The minimum diameter will be as per the specifications or contract or any other written agreement between the Client and the contractor. It is preferred that drilling starts with a small diameter, and then reamed to the right size.

## **10. Temporary casing**

In order to prevent the collapse of unstable strata, the contractor may use temporary casings. These temporary casings will be provided by the contractor and removed after use. Installation and diameter (*which should not be less than 8 inches*) of any temporary casing required for the construction of the borehole will be at the discretion of the Contractor provided that the finished product meets the specifications and is approved by the Supervisor. Cost for supply, installation and removal of temporary casing shall be borne entirely by the Contractor. The Contractor cannot claim from the employer any temporary casing left in the borehole that is not retrievable.

## **11. Casing and screens**

Aquifer zones shall be completely or partly lined with uPVC screen as per the specifications and approved by the Supervisor. The Supervisor however reserves the right to vary these specifications

and reject materials if found substandard. The permanent casing shall be of unplasticised polyvinyl chloride complying with DIN 8061 and DIN 8062 or (ISO 16111) standards. The casing and screens shall be 8/7/6/5" ND and shall have a minimum thickness of 6 mm and tensile strength of at least 45MN/m<sup>2</sup>. The PVC pipes shall be joined by threads and the joints shall be watertight. Filter pipes (screens) shall be of slotted unplasticised polyvinyl chloride (*rigid PVC uPVC*), complying with DIN 4925, year 1981 standard. Sections of the screen shall be provided in maximum 3m length and joined water tight by either flush threaded connections or by an appropriate method recommended by the screen manufacturer or an equivalent standard, so that the resulting joint shall be strong and have the same structural integrity as the casing and screen themselves.

In particular cases the lower end of the screen should be completed with a sump of minimum 0.5m and maximum 2m length. The collapse resistance of the casings shall normally be a minimum of 6.5kg/cm<sup>2</sup>. The screen open area shall be between 6-10% and shall have a uniform slot size of between 0.5-1.5mm.

Sections of the screens shall be provided in 3m lengths and joined water tight by either flush threaded connections, or by an appropriate method recommended by the manufacturer or an equivalent standard, so that the resulting joint shall be strong and have the same structural integrity as the casing and the screen themselves. In particular cases the lower end of the screen shall be completed with a sump of minimum 0.5m and maximum 2m length. The bottom end shall be sealed with a suitable bottom cap or cement seal. The casing should extend at least 0.3 metres above the ground surface. The contractor will transport and store the casing pipes at the drilling site, in such a way as to prevent distortion and bending of the pipe.

## **12. Verticality and Alignment**

All wells shall be vertical, shall be drilled and cased straight, and all casings/screens shall be set round, plumb and true to line. If required by the Client, the Contractor shall ensure that the departure from the verticality does not exceed 3mm for every 10m between ground level and the bottom of the well. If this departure is exceeded, the Contractor shall make the necessary corrections to the approval of the Client, without additional payment. If the error cannot be corrected, then drilling shall cease, and a new borehole shall be drilled at a position nearby, indicated by the Supervisor.

## **13. Lost/abandoned borehole**

"Lost" boreholes are either "dry" boreholes or "uncompleted/technically failed" boreholes.

### **13.1 Dry Boreholes**

In these guidelines, dry boreholes are defined as follows:-

13.1.1 A borehole having no water bearing zones/aquifers.

13.1.2 A Borehole that has insufficient discharge (less than 500 liters/hour) for 3 hours of continuous pumping test, in case of a hand pump.

13.1.3 A borehole with stabilized Dynamic Water Level of more than 90 meters at minimum acceptable discharge of 500litres/hour for a hand pump.

### **13.2 Uncompleted/Technically failed Borehole**

13.2.1 For any reasons, contractor is unable to continue drilling and complete the construction of borehole then this borehole is deemed to be an “uncompleted“ borehole.

13.2.2 In case of “uncompleted” boreholes, no payment shall be made for that borehole either for drilling or materials that cannot be salvaged and the rig's unproductive time spent. If the Contractor chooses to deviate from standard procedure and the agreed method of drilling, and wishes to adopt any other procedure or techniques that involve(s) any additional cost and time required, it will be done so entirely at the Contractor's own risk and cost.

13.2.3. In case of “technically failed” borehole the water quality may not meet the National guidelines for drinking water. In this case the contractor is paid for the work done.

If completion of the well is prevented by any incident to the plant, behavior of the ground, jamming of the tools, or casing or any other cause, the well shall be deemed to be lost/abandoned. There shall be no payment made for that borehole or for any materials not recovered therefrom, nor for any time spent during drilling or while attempting to overcome problems.

In the event of a lost borehole, the Contractor shall construct a new well. The option of declaring any bore lost shall rest with the Contractor, subject to the approval of the Client.

#### **A lost/abandoned/uncompleted borehole shall be treated as follows:-**

- a) The Contractor may salvage as much casing and screen from the lost well as possible, and may use it if not damaged in a replacement well, with the approval of the Client or his representative.
- b) Any material supplied by the Client and salvaged damaged shall become the property of the Contractor, and the Contractor shall compensate the Client accordingly.
- c) The lost bore shall be sealed by concrete or cement grout or neat cement, which shall be placed from 2m-5m below ground and the rest of the hole with drill cuttings or other materials like aggregates.
- d) The upper 2 meters of the lost bore shall be backfilled with native top soil. Sealing of such abandoned wells shall be done in such a manner as to avoid accidents or subsidence, and to

prevent it from acting as a vertical conduit for transmitting contaminated surface or subsurface waters into the water bearing formations.

#### **14. Water supply for drilling**

The contractor shall make his own arrangement for obtaining, transporting and pumping of water required for drilling purposes in case of mud drilling and for use by the drilling crew at their camp site.

#### **15. Well design**

The final design of the borehole shall be confirmed by the Client or his representative in consultation with the Contractor during the drilling process. Drilling should preferably be started with the smallest size and then the borehole reamed to the right size based on observations of the nature of formation penetrated and the volume of water obtained. The size of the casing size to be installed will depend on the anticipated or estimated yield of the borehole, and as defined in the contract. Typical standard borehole designs are described below.

##### **For Large Diameter Boreholes (Well Field Boreholes)**

**Design B:** Drilled at 400-420mm (12" to 14") through soft collapsible overburden until firm rock is encountered. Drilled further with (203-250) mm bit for 3m or more through non-collapsing formation. Cased fully with 7.5"/7" (191mm/177mm) ND uPVC Class D casing, 6mm wall thickness. The size of the casing will depend on the volume of water encountered. Drilling to continue with 203mm bit to final depth. Screened sections adjacent to aquifer zones at depths as instructed by the Supervisor. The screened sections are to be gravel packed. Bottom annular space between uPVC casing and borehole to be grouted with cement slurry of 1.67-2.08 Kg cement/litre (24-30 litres of water per 50 Kg bag of cement). Grout is to be injected into the annulus using tremie pipes, or a method approved by the Supervisor, in a continuous operation so that a complete and continuous seal is achieved.

##### **For Production Boreholes**

**Design B:** Drilled at 300mm (12") through soft collapsible overburden until firm rock is encountered. Drilled further with 250mm (10") bit for 3m or more through non-collapsing formation. Cased with 6"/6.5" (152/165mm) ND uPVC Class D casing, 6mm wall thickness. Screened sections adjacent to aquifer zones at depths as instructed by the Supervisor. The screened sections are to be gravel packed. The size of the casings and their length should depend on the amount of water anticipated or obtained. Drilling to continue with 175 mm (7") bit to final depth. Bottom annular space between uPVC casing and borehole to be grouted with cement slurry of 1.67-2.08 Kg cement/litre (24-30 litres of water per 50 Kg bag of cement). Grout is to be injected into the annulus using tremie pipes, or a method approved by the Supervisor, in a continuous operation so

that a complete and continuous seal is achieved. In general, since these boreholes are installed with motor driven pumps, it is preferred that they are fully cased.

The following table can be used for guidance.

Yield [m <sup>3</sup> /hr]	Pump Duty lift [m]	Motor/Pump dia. [mm]	Rising Pipe dia.	Min Casing dia.
<8	<170	95 / 101	2"	5"
<14	<110	95 / 101	2"	5"
<17	<75	95 / 131	2½"	6"
<17	<220	138 / 142	2½"	6"
<30	<190	138 / 142	3"	6"
<46	<170	138 / 147	4"	8"
<60	<180	138 / 147	5"	8"
<77	<130	143 / 200	5"	8"
<95	<95	143 / 200	5"	8"
<95	<150	192 / 209	5"	10"

In general the casing diameters in the table below will suit the areadily available pumps.

Desired Yield [m <sup>3</sup> /hr]	Minimum Casing Internal Diameter
15	5"
36	6"
54	8"
90	10"

NB: It should be noted that research and development in drilling methods, tools and borehole equipment is a continuous activity and the data in the tables above may routinely be superseded by new developments. From this table, a borehole could be drilled with a small diameter and reamed if it is above 15m<sup>3</sup>/hr to use 6"/7" casing, otherwise 5" casing is sufficient.

### **For Hand Pumps**

**Design A:** Drilled at 10<sup>5</sup>/<sub>8</sub> inch (270mm) through soft collapsible overburden until firm rock is encountered. Drilled further with 8½ or 6½ inch (215mm – 165mm) bit for 3m or more through non-collapsing formation or competent rock. Cased with 5"/6" 127/152 ND uPVC Class D casing, 6mm wall thickness. Drilling to continue with 4½inch (114mm) bit to final depth. Bottom annular space between uPVC casing and borehole to be grouted with cement slurry of 1.67-2.08 Kg cement/litre (24-30 litres of water per 50 Kg bag of cement). Grout is to be injected into the annulus using pump and tremie pipes, or a method approved by the Supervisor, in a continuous operation so that a complete and continuous seal is achieved.

**Design B** : Drilled with 10 inch (254mm) bit to final depth and where necessary finished with 8 inch bit to final depth. Cased with 5" (127mm) ND uPVC Class D casing. Screens are placed adjacent to aquifer zones at depths as instructed by the Supervisor. The screened sections are gravel packed. This type of design is used when water is obtained in unconsolidated formation of highly fractured/weathered formation which is not strong enough to stand on its own.

## 16. Gravel pack

The Contractor shall supply suitable gravel pack. Prior to delivery, samples of the gravel pack shall be subjected to a grain size analysis at the Contractor's expense. The Contractor shall be required to submit samples of the gravel pack material prior to installation for approval by the Supervisor. Gravel pack shall consist of washed, well-rounded particles of a uniform grading of between 2.5 and 4.0mm, shall comprise at least 95% siliceous material and must contain no clay, shale, silt, fines, excessive amounts of calcareous material or crushed rock.

Gravel packing is carried out as continuous feed operations done usually by two people filling uniformly around the circumference of the pipe. It is advisable to add some water with a pipe so that the gravel flows down. If the gravel gets inside the temporary casing, the casing is slowly pulled out and gentle well development is done to allow gravel to settle properly to a height of 3 meters above the top of the screen interval or the targeted water bearing formation. More gravel is added with development if the gravel settles down.

Where possible emplacement should be by means of a conductor pipe, and a good supply of water should be introduced with the gravel to prevent "bridging". The tremie (*conductor*) pipe should be raised gradually as the level of the gravel builds up. The pack should be capped with a clay seal to prevent contamination. The annular space above this seal can be back-filled with inert drill cuttings. The top 3 metres of the annular space should be grouted, leaving 0.4 meters at the top for construction of the pump pedestal.

## 17. Sanitary seal

To provide an effective seal to the entry of contaminants, the upper **3 meters** of the annular space between the casing and the well wall shall be grouted using suitable prepared cement slurry of 1.85-2.15 kg cement/litre. Grout is to be injected into the annulus in a single operation so that a complete and continuous seal is achieved.

## 18. Development and cleaning of wells

Development and cleaning of the wells, in order to remove native silts, clay and drilling fluid residues deposited on the well wall during the drilling process, shall be carried out by the Contractor upon completion of the drilling and installation of casings. The borehole should be

flushed until it is free of fines and turbidity for a continuous period / intermittently until the water has fully cleared. Development should be done at the level of water strikes, on screens and raise the water level, then let it fall back by switching the compressor on and off, while recording the time taken during development.



### **Demonstration of borehole development**

Whenever possible, natural well development must be used. If organic drilling fluids are used, they shall be broken down chemically according to the manufacturer's recommendations before or during development. Cleaning may be carried out by airlift pumping, surging, backwashing or jetting, to the approval of the Client. Clay de-segregation by means of Sodium Hexametaphosphate ("Calgon") treatment may, in some cases, also be called for by the Client/Supervisor.

Developing shall be carried out by airlift pumping and surging, jetting and block surging, or other techniques the contractor feels is more appropriate and efficient to suit the casing, hydrogeological and drilling conditions prevailing in that borehole. All boreholes shall be presented for pumping test free of any bridging or obstruction to the total depth.

Development shall continue for such time as directed by the Client or his representative and until the Client is satisfied that the water is as free from fine particles as possible. Upon completion of development, any accumulation of material shall be removed from the bottom of the well by airlifting. It is anticipated that the total time for development shall not exceed six hours.



**Airlift yield estimation during drilling**

## **19. Pumping Tests**

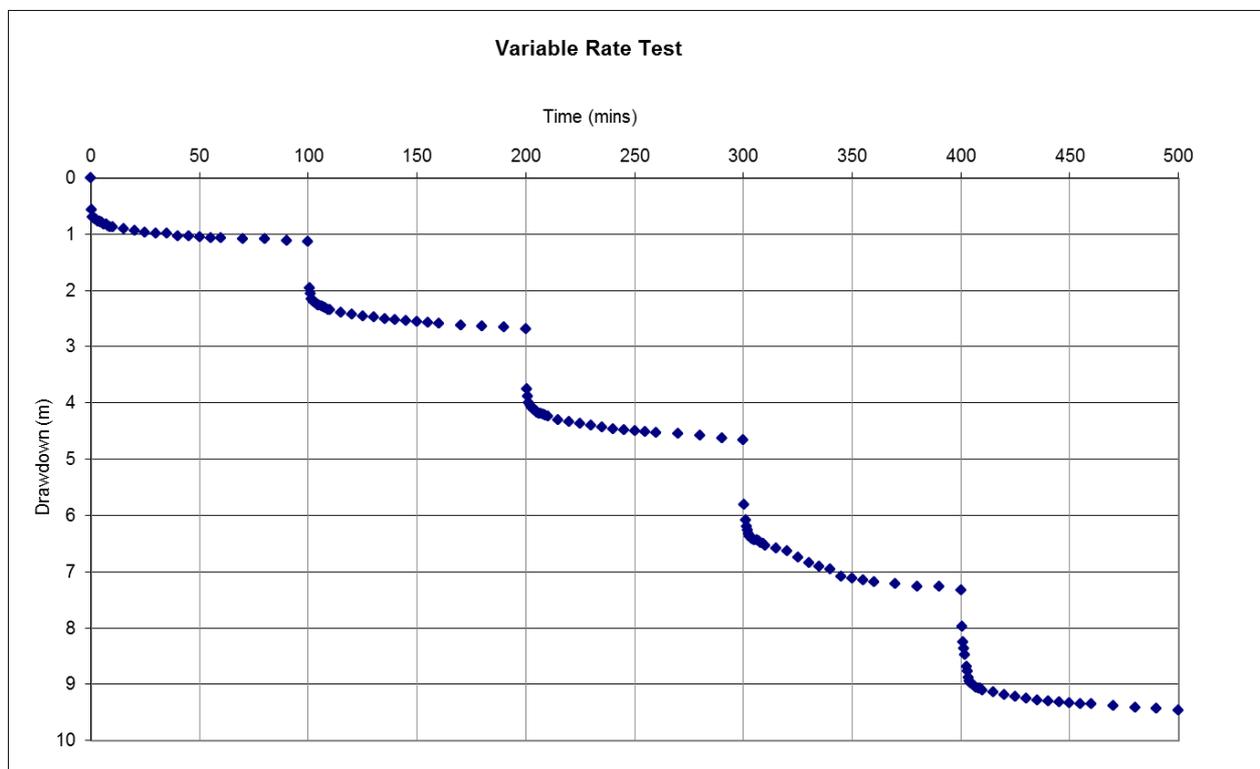
The Contractor shall perform test pumping to establish the performance and yield of the borehole, and shall provide a suitable, self-contained, mobile test pumping unit, approved by the Supervisor, for this purpose. The type of test will depend on the yield and the use of the borehole. The Contractor shall ensure the provision of a suitable means of achieving the range of constant flow rates specified by the Supervisor. Test pumping will be undertaken in each productive borehole, as assessed by the Supervisor from the yields indicated during drilling. The depth of installation of the pump for the test shall be above the lowest water strike. Test Pumping will take place for at least 3-hours at a yield of 1000 litres per hour or as specified in the contract agreement. for all hand pumps unless otherwise directed by the Client or Supervisor.

Boreholes to be installed with motor driven pumps will initially be tested in the manner of step tests with the initial step being at approximately  $\frac{1}{3}$  of driller's estimated yield; the 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> steps will be approx.  $\frac{2}{3}$ ,  $\frac{3}{3}$  and  $\frac{4}{3}$  of driller's estimated yield; additional steps may be recommended by the supervisor and the last step should stress the borehole (*steep drop in water level*). The duration of each step shall be 90 minutes and a minimum of three steps of increasing discharge will be undertaken. The final step should lower the dynamic water level to approximately three metres above the level of the pump. Discharge for each step should be kept constant. On completion of the final step, the recovery of water level should be monitored by the

Contractor until 95% recovery has been achieved, or until advised by the Supervisor. The well should then be tested for 72hours at a constant discharge rate based on the step test results and as mutually agreed upon by the Supervisor and the drilling contractor. After which the well should be allowed to recover to 95% or as advised by the Supervisor.

Water levels shall be measured during test pumping by the Contractor by means of an electric contact gauge (*dipper*), suitably calibrated such that measurements can be made to an accuracy of 5mm. The frequency of measurement shall be as specified on an agreed test pumping data form or as otherwise determined by the Supervisor.

Discharge shall be measured by volumetric methods, or by means of some other approved calibrated measuring device. Control of the discharge shall be provided by direct measurement into a drum of known capacity, supplied by the Contractor and shall form part of his standard equipment under this Contract. For yields greater than 15m<sup>3</sup>/hr the drum shall be of a 200 litres capacity. For yields above 7m<sup>3</sup>/hr and less than 15m<sup>3</sup>/hr, the drum shall be of a 100 litres capacity. For yields less than 7m<sup>3</sup>/hr, the bucket shall be of a 25 litres capacity. The stopwatch used must be able to read to at least 1/10 of a second.



**Step /variable rate test results graphically demonstrated.**

During the test pumping, the discharged water must be handled and disposed of in an appropriate manner to a point of overland drainage, sufficiently far from the borehole to prevent recharge of the well under test. This distance shall be at least 100m downslope from the wellhead, but may be reduced with the approval of the Supervisor, if the pumped aquifer is confined. Water discharge

measurements shall be taken together with Electrical Conductivity (EC) and pH readings at appropriate time intervals as instructed by the Supervisor.

During all testing operations, once the flow rate has been determined and preliminary adjustments made, the measured discharge rate shall be maintained within 5% of the required rate for the duration of the test or test stage. Persistent fluctuations beyond this tolerance will require abortion of the test.

When continuous pumping at a uniform rate is specified, failure of the pump operation for a period greater than one percent of the elapsed pumping time shall also require abortion of the test. Any test which is aborted due to the reasons above shall be repeated, after full recovery of the water level. No payment shall be made to the Contractor for aborted tests, nor for standing time during water level recovery after aborted tests.

After completion of the test, the data shall be handed over to the Supervisor from all pumping tests conducted at the borehole. These will show dates, water levels, discharge rates, electrical conductivity values, times of starting and stopping the pump, changes in discharge, weather, and other conditions that could affect the test data. Further details on test pumping are embedded in the Manual for Test pumping.

## **20. Water level observations**

The contractor shall apply appropriate electronic contact water level gauges for measuring water levels in the wells. Measurements shall be made at predetermined intervals, depending on the nature of the test. Well head arrangement shall permit these gauges to be inserted.

## **21. Water Quality Testing**

Before the end of pumping test, water samples shall be collected for water quality analysis as directed by the Supervisor. Water samples shall be taken for water quality testing by the Contractor to MWE Laboratories, Makerere University; or other Laboratories approved by the Employer. The water quality testing for physical and chemical analysis will be done as per the National Guidelines, or as specified by the Client. The samples should reach the laboratory within 6 hours from the time of collection and all major cations and anions should be analysed. Specific parameters to be measured include:-

### Physical requirements for potable water

Sl. No.	Characteristic	Treated potable water	Natural potable water
i)	Colour (TCUa max)	15	50
ii)	Turbidity (NTU max)	5	25
iii)	pH	6.5 – 8.5	5.5-9.5
iv)	Taste	Not objectionable	Not objectionable
v)	Odour	Odourless	Odourless
vi)	Conductivity ( $\mu\text{S}/\text{cm}$ ) max	1500	2500
vii)	Suspended matter	Not detectable	Not detectable

True colour units (TCU) mean 15 hazen units after filtration.

### Quality requirements for potable water

Sl. No.	Substance or characteristic	Treated potable water (mg/L max.)	Natural potable water (mg/L max.)
i)	Total dissolved solids	700	1500
ii)	Total hardness, as $\text{CaCO}_3$ ,	300	600
iii)	Aluminium, as $\text{Al}^{+++}$ ,	0.2	0.2
iv)	Chloride, as $\text{Cl}^-$	250	250
v)	Total Iron as Fe	0.3	0.3
vi)	Sodium, as $\text{Na}^+$	200	200
vii)	Sulphate $\text{SO}_4$	400	400
viii)	Zinc, as $\text{Zn}^{++}$	5	5
ix)	Magnesium, as $\text{Mg}^{++}$	100	100
x)	Calcium, as $\text{Ca}^{++}$	150	150
viii)	Zinc, as $\text{Zn}^{++}$	5	5
ix)	Magnesium, as $\text{Mg}^{++}$	100	100
x)	Calcium, as $\text{Ca}^{++}$	150	150

**Source:** Uganda National Bureau of Standards

## **22. Capping of well**

During well construction, installation, development and test pumping, the Contractor shall use all reasonable measures to prevent entrance of foreign matter into the well. Well caps should be used at all times. Wooden logs shall not be used to replace well caps. As a minimum, the Contractor shall install a Ull pedestal or a metallic casing with lockable cover plate bolted onto it or a lockable metallic cage and the padlock keys handed-over to the responsible authority or as may be directed by the Supervisor. The Contractor shall be responsible for any objectionable materials that may fall into the well and any effect it may have on water quality or quantity until completion of the Works and acceptance by the Client.

## **23. Acceptance of well**

The Client shall accept the well upon satisfactory completion of all drilling operations, installation of casings and screens, development works, pumping tests, presentation and approval of complete drilling reports and logs and provided the well yield is above minimum recommended values. The borehole shall only be acceptable by the Supervisor upon satisfactory completion of all drilling operations as specified in the drilling contract agreement. The contractor will prepare a report indicating key parameters of the boreholes constructed. These are, but not limited to the following:- location of the borehole, casing depth, total depth, yield, etc. This report should include photos for all the boreholes constructed. This shall be additional to the summary as in section 30.

## **24. Clearing the site**

On completion of each borehole the site must be left clean and free from all debris, hydrocarbons and waste, and all pits used during drilling back-filled to the satisfaction of the Supervisor. A site not delivered clean may render the borehole unacceptable.

## **25. Standby time**

The Contractor shall provide the Client with 48 hours' notice before starting any works that need to have the Client's supervisor on site as well as 48 hours' notice when mobilizing to the next site.

## **26. Concrete apron/platform casting and hand pump installation**

Upon receipt of satisfactory water quality results and after being verified by the Client, the contractor shall cast a concrete slab on the wells according to the specifications as detailed below. The Contractor shall construct concrete platform for each successful borehole carrying out the following activities in the following order:-

- a) Excavate a square pit 760x760x400mm deep around casing pipe.

- b) Place the stand assembly (*pedestal*) over casing pipe, ensuring third leg (*corresponding to the water tank spout pipe position*) faces the proposed direction of the drain.
- c) Making sure the pedestal is vertical, construct concrete in layers of 100mm up to top of legs.



**Demonstration of borehole casting**

- d) Pedestal assembly with a cover plate and level the ground around the pump pedestal.
- e) Lay the mild steel shuttering (*molds*) and cast platform in mass concrete (*mix 1:2:4/20mm agg.*) conforming to the dimensions and other specifications shown in the drawings.
- f) Cure concrete for 3 days and protect it from excessive sunshine (*using gunny bags and thorny bushes, etc.*).
- g) Plaster the platform and drain in cement screed to a smooth finish, then engrave the borehole details provided by the Client on the platform.

In practical terms, 1:2:4/20mm means one volume of cement, two volumes of sand and four volumes of aggregates of 20mm.

## **27. Hand pump equipment and installation**

The Contractor shall supply pipes and pump parts, to cast and install India Mark II Deep well Hand pump as per agreement, with cast iron brass sleeved open top cylinder assembly with extractable plunger and foot valves assemblies or a similar specification according to the National standards. Note that all pipes and rods must be of stainless steel of grade 304, or better, unless specified by the Client. If conditions allow, where pH <6.5, and when directed by the Client, uPVC pipes may be substituted for stainless steel.

The Contractor shall supply Either Grade 304 Stainless steel pipes, 1¼” Nominal pipe diameter, 3m long with average weight of 2.73 Kg/m and Stainless steel rods of grade 304, not less than 17mm diameter, together with two rod centralizers for pump installation greater than 36m deep; or 3m in length uPVC 40mm diameter riser pipes with stainless steel coupler design; male threads insert fitted and crimped at one end and female threaded stainless steel socket fitted and crimped at the other. Each pipe shall be fitted with two centralizers and stainless steel rods of SS304 and not less than 17mm diameter for pump installations not greater than 36m.

## **28. Records and Reporting (see Annex I)**

The Contractor shall prepare a Borehole Completion Report that includes drilling, pump testing, water quality and Installation data, according to the standard forms that shall be laid out as specified below:-

In addition separate records should be supplied for each borehole upon completion.

### **I Daily Record**

- Site name
- Reference number of borehole
- Coordinates of borehole (*UTM Arc 1960 Coordinates*)
- Date of reporting
- Names of foreman and drillers
- Method of drilling
- Diameter of hole, and depth of changes in diameter
- Depth of hole at start and end of shift or working day
- Depth and size of casing at start and end of shift or working day
- Description of strata drilled with depth of transitions encountered
- Depth at which water is struck
- Yield of air lifted water, when drilling or developing with air.
- Time log showing rate of penetration in minutes per metre, type of bit, standby time due to breakdown.
- Depth intervals at which formation samples are taken
- Records of components and quantities used or added to the drilling fluid or air.
- Water level at the start of each working day
- Electrical conductivity measurements during test pumping
- Problems encountered during drilling
- Details of installations in the borehole (if any)
- Depth and description of well casing
- Depth and description of well screens
- Details of work to be invoiced at hourly rates (*e.g. test pumping*)

A copy of the Daily Record shall be made available daily to the Supervisor, and should include any other pertinent data as may be requested for by the Supervisor.

**ii) Borehole Completion Record**

- As per standard Borehole Completion Form.
- Detailed drillers log.
- Borehole design (as-built drawing)

A copy of the Borehole Completion Record shall be made available to, and approved by the Supervisor on completion of each borehole, before being forwarded to the Client. Three copies of these Records shall be forwarded to DWD, and one copy each to the Client and the Supervisor.

**iii) End of Contract Report**

The Contractor is required to prepare an End of Contract Report, which should address at the minimum the following issues:-

1. The drilled sites  
*(Location and National ID Numbers)*
2. The drilling /test pumping methodologies  
*(Type of drilling, designs used, test-pumping methods)*
3. Contract schedules and duration  
*(Summarised diary of events and actual durations)*
4. Summary of construction results and analysis.  
*(Table showing locations, well numbers, depths, casing type and depths, driller's and test pumping yields and any other information necessary)*
5. Problems encountered  
*(With accessibility, formations, equipment and community, etc.,)*
6. Suggestion for improvement  
*(On supervision, documentation, durations, etc.,)*
7. Borehole Completion Records,  
*(Original drilling and test pumping logs bound at end of the report)*

## **ENVIRONMENTAL GUIDELINES AND CODE OF CONDUCT**

Groundwater exploration and development work should be conducted in an environmentally and socially sensitive and responsible manner. These guidelines are intended to ensure that all parties are aware of the potential impacts of their activities, and carry out the work in an appropriate way.

These guidelines are intended as a written statement of intent for Contractors to adhere to, and to which recourse can be made in the event of a perceived undesirable impact. Contractors are required to familiarize all employees with the content and spirit of these guidelines.

### **I. Camps**

If and where field camps are needed, their construction and removal should be carried out along the following lines:-

- Permission for camp areas must be obtained in writing from the relevant local authorities.
- Suitable latrines and other sanitary arrangements at the camps and sites where work is in progress should be availed to the crew. These facilities, if newly constructed, should be suitably located to prevent pollution of ground water.
- Access roads and the camp area should be sited to cause minimum disturbance. Where possible, no trees should be cut down, the use of firewood must be restricted to dead wood only and should not conflict with the needs of the residents of the area.
- No permanent structures should be built at the camp.
- The camp should be removed; the site cleared and cleaned free of all debris, waste and hydrocarbons at end of the Contract and local authorities should be shown the cleared site.
- All rubbish (*except for oils and other mechanical or chemical waste*) should be buried or removed.
- Waste oils, chemical and mechanical waste should be stored and removed to Government/Municipal designated dumping sites or recycling plants.

### **2. Human Relations**

- People, water, land and livestock must be respected.
- Access routes should not normally transgress gardens. But if found necessary, permission to enter the gardens must be sought from the owner. Work should be done with minimal damage to fences, trees or crops.
- All conflicts / disagreements and any agreements (*use of water supply etc.*), no matter how trivial, must be logged and dated, with details of persons involved and subject

matter, in a book for this purpose at the base camp.

### **3. Drillings Sites**

- Each drilling site should be completely cleared of all waste after use. Drilling waste (*chippings and mud*) should be buried. Rubbish, waste oil and chemicals should be returned to the main camp for disposal as outlined in one (1) above.
- No spillage of oils or fuels should occur.
- On completion of each borehole the site must be left clean and free from all debris, hydrocarbons and waste, and all pits used during drilling must back-filled to the satisfaction of the Supervisor.

## STANDARD BILLS OF QUANTITIES

<b>BOQ I (HAND PUMP WELLS)</b>					
<b>Bill No. 1 PRELIMINARIES &amp; GENERAL</b>					
<b>Item</b>	<b>Description</b>	<b>Unit</b>	<b>Qty</b>	<b>Rate[US\$]</b>	<b>Amount[US\$]</b>
<b>1.0</b>	<b>PRELIMINARIES AND GENERAL</b>				
1.2	Insurance of Works, construction Plant and against damage to persons and property.	Sum	LS		
1.3	Mobilisation of personnel, equipment and materials.	Sum	LS		
1.4	Provision of all temporary facilities for use of the Contractor	Sum	LS		
1.5	Preparation and submission of Completion Report( With Photos)	Sum	LS		
<b>Total of Bill No. 1 carried to Summary</b>					
<b>2</b>	<b>BOREHOLE CONSTRUCTION</b>	<b>Unit</b>	<b>Qty</b>	<b>Rate[US\$]</b>	<b>Amount[US\$]</b>
2.1	Setting up and dismantling at every site.	No	1		
2.2	Shifting between sites.	km	30		
2.3	Drilling in overburden at 250mmdiameter including installation and removal of temporary casing pipe (0-25m)	m	20		
2.3.1	Drilling in overburden at 250mmdiameter including installation and removal of temporary casing pipe (25-50m)	m	5		
2.4	Drilling in consolidated formation(fractured zone) at 203mm dia(0-50)m	m	10		
2.4.1	Drilling in consolidated formation(fractured zone) 203mm dia (50-100m)	m	5		
	Reaming of borehole from 203 mm to 254mm	m			
2.5	Drilling in hard rock 114-150 mm dia. (0-50m)	m	20		
2.5.1	Drilling in hard rock 114-150 mm dia. (50-100m)	m	15		
	Reaming of in hard rock 152 – 177 mm diameter	m			
2.5.2	Sampling and Storage of drill cuttings at 3m intervals or as instructed by the Engineer	No	1		
2.6	Supply and Installation of uPVC casings 127mm, including centralizers and bottom cap.	m	30		
2.6.1	Supply and Installation of uPVC screens 127mm.	m	6		
2.7	Supply and installation of cement grouting.	No	1		
	Supply and installation of gravel pack.50kg	Bag	50		
2.8	Supply and installation of inert backfill	No	1		
	Casting a sanitary seal.	No	1		
2.9	Well Development.	Hr	2		
2.10	Test Pumping:				
	Movement	Km	30		
	Test Pump Installation and Removal	No	1		
	Pumping Time	Hr	3		
	Recovery Time	Hr	1		
2.11	Water sampling	No	1		
	Water Quality analysis	No.	1		
2.12	Treatment of failed and abandoned boreholes the failure of which is not attributed to the Contractor	No	0		
2.13	Clearing Site	No	1		
2.14	Standing Time	Hr	0		
2.15	Engraving of well parameters	No	1		
<b>Total of Bill No 2 carried to summary</b>					

### HANDPUMP PLATFORM CASTING AND INSTALLATION

Item	Description	Unit	Qty	Rate[USh]	Amount[USh]
3.1	Platform casting (1:2:4) mixing ratio and channel 6m	No	1		
3.1	Supply and installation of U2 hand pump with pedestal, water tank, pump head and cylinder	No	1		
3.2	Supply and Installation of Poly Propylene Pipes (PPR) rising pipes and rods.	m	36		
3.3	Supply and Installation of Stainless Steel rods - U2 pump	m	1		
<b>Total of Bill No. 3 carried to Summary</b>					
Item	Description	Unit	Qty	Rate[USh]	Amount[USh]
<b>DAY WORKS (PROVISIONAL)</b>					
A	Works				
A-1	Drilling in hard rock 114-150 mm dia. (100-150m)	m			
A-2	Drilling using Mud Rotary method 0-50m	m			
A-3	Drilling using Mud Rotary method 50-100m	M			
A-4	Supply and Installation of U2 rising pipes and rods.	M			
A-5	Supply and Installation of uPVC pipes {UNBS Approved} – U3M	M			
A-6	Provisional sum for supply of U3M hand pump complete with above ground super structure {UNBS Approved}	No.			
<b>B</b>	<b>Labour and tools</b>				
B-1	Skilled labour { Chief Driller}	hrs			
B-2	Unskilled labour	hrs			
B-3	Materials				
B-4	Ordinary Portland Cement	Bags			
B-5	Gravel Pack	Bags			
B-6	Plants				
B-7	Drilling Unit	hrs			
B-8	Support truck { 25 tons GVW}	Kms			
B-9	De-silting of the existing borehole	No			
B-10	Provisional sum for supply of U2 extra deep hand pump complete with above ground super structure from bgl 45m To 90m {UNBS Approved}	No			
B-11	Removal and reinstallation of hand pump on existing borehole.	No			
B-12	Total of Bill No 4 carried to Summary				
B-13	Preliminaries and General				
B-14	Borehole Construction				
B-15	Hand pumps and Installation				
B-16	Summary Sub-Total				
B-17	Less Discount(if any)				
<b>Add 18% VAT</b>					
<b>GRAND TOTAL</b>					

	<b>BOQ 2 (PRODUCTION WELLS)</b>				
	<b>Bill No. 1 PRELIMINARIES &amp; GENERAL</b>				
<b>Item</b>	<b>Description</b>	<b>Unit</b>	<b>Qty</b>	<b>Rate [USh]</b>	<b>Amount [USh]</b>
<b>1</b>	<b>PRELIMINARIES AND GENERAL</b>				
1.2	Insurance of Works, construction Plant and against damage to persons and property.	Sum	LS		
1.3	Mobilisation of personnel, equipment and materials.	Sum	LS		
1.4	Provision of all temporary facilities for use of the Contractor	Sum	LS		
1.5	Preparation and submission of Completion Report(With Photos)	Sum	LS		
<b>Total of Bill No. 1 carried to Summary</b>					
<b>2</b>	<b>BOREHOLE CONSTRUCTION</b>	<b>Unit</b>	<b>Qty</b>	<b>Rate [USh]</b>	<b>Amount [USh]</b>
2.1	Setting up and dismantling at every site.	No	1		
2.2	Shifting between sites.	Km	30		
2.3	Drilling in overburden at 300mmdiameter including installation and removal of temporary casing pipe (0-25m)	M	20		
2.3.1	Drilling in overburden at 300mm diameter including installation and removal of temporary casing pipe (25-50m)	M	10		
2.4	Drilling in consolidated formation(fractured zone) at 254mm (0-50)m	M	20		
2.4.1	Drilling in consolidated formation(fractured zone) 254 dia (50-100m)	M	25		
2.4.2	Drilling in consolidated formation(fractured zone) 203mm dia (100-150m)	M	0		
2.5	Drilling in hard rock 152-177 mm dia. (0-50m)	M	0		
2.5.1	Drilling in hard rock 152-177 mm dia. (50-100m)	M	25		
2.5.2	Drilling in hard rock 152-177 mm dia. (100-150m)	M	20		
2.7	Sampling and Storage of drill cuttings at 3m intervals or as instructed by the Engineer	No	1		
2.9	Supply and Installation of uPVC casings 168mm, including centralizers and bottom cap.	M	102		
2.9.1	Supply and Installation of uPVC screens 168mm.	M	18		
2.10	Supply and installation of cement grouting.	No	1		
	Supply and installation of gravel pack.50kg	Bag	60		
2.11	Supply and installation of inert backfill	No	1		
	Casting a sanitary seal.	No	1		
2.12	Well Development.	Hr	3		

2.13	Test Pumping:				
	Movement	Km	30		
	Test Pump Installation and Removal	No	1		
	Step Tests	Hr	4.5		
	Pumping Time Constant Discharge	Hr	<b>72</b>		
	Recovery Time	Hr	<b>4</b>		
2.14	Water sampling	No	1		
	Water Quality analysis	No.	1		
2.15	Well Construction Works				
	Protection cage (800mm*600mm*600mm)	No	1		
	<b>Standard Concrete Base platform (1:2:4 ratio mix) with drainage channel and soak-away pit</b>	Point No.	1		
	Protection steel casing pipe (over 200mmdiameter) with cap <b>Installation of UII pedestal with padlocked cover plate</b>	No	1		
2.16	Treatment of failed and abandoned boreholes the failure of which is not attributed to the Contractor	No	0		
2.17	Clearing Site	No	1		
2.18	Standing Time	Hr	0		
2.19	Engraving of well parameters	No	1		
	<b>Total of Bill No 2 carried to summary</b>				
	<b>Summary</b>				
	Preliminaries and General				
	Borehole Construction				
	Summary Sub-Total				
	Less Discount(if any)				
	Add 18% VAT				
	<b>GRAND TOTAL</b>				
	<b>PROVISIONAL</b>				
A	<b>Works</b>				
A-1	Drilling in hard rock 152-177 mm dia. (150-200m)	M			
A-2	Drilling using Mud Rotary method 0-50m	M			
A-3	Drilling using Mud Rotary method 50-100m	M			
A-4	Supply and Installation of uPVC casings 178mm, including centralizers and bottom cap.	M			
A-5	Supply and Installation of uPVC screens 178mm.	M			
	<b>SPECIALISED PUMPING TESTS – FOR HIGH YIELDING WELLS – Q &gt; 50m<sup>3</sup>/hr</b>				

A-6	Pumping Time: power generator 50 KVA to 82.5 KVA -3 phase, mounted on a self-loading 4x4 truck and submersible pump of flow rate 60m <sup>3</sup> /h to 100m <sup>3</sup> /hr at a head of 50 to 75 meters, with 2½" or 3" outlet.	Hr			
A-7	Test Pump Installation and Removal for high yielding boreholes(Hydraulic winch )	No			
	<b>Description</b>	<b>Unit</b>	<b>Qty</b>	<b>Rate [USh]</b>	<b>Amount [USh]</b>
<b>B</b>	<b>DAY WORKS</b>				
B-1	Labour and tools				
B-2	Skilled labour { Chief Driller}	Hrs			
B-3	Unskilled labour	Hrs			
B-4	Materials				
B-5	Ordinary Portland Cement	Bags			
B-6	Gravel Pack	Bags			
B-7	Plants				
B-8	Drilling Unit	Hrs			
B-9	Support truck ( <b>upto 25 tons GVW</b> )	Km			
B-10	Supply and Installation of 6" Iron ('C' class) casing	M			
B-11	Supply and Installation of 6" Iron ('C' class) screen casing	M			

### BOQ 3. LARGE DIAMETER WELLS FOR WELL FILEDS.

ITEM	DESCRIPTION	Unit	Qty	Rate[USh]	Amount[USh]
1	Mobilization of equipment manpower and materials	l	Sum		
2	Ground Water Assessment & Hydro geological survey	0	No		
3	Set up and dismantling of the drilling unit on site including set up of camp and all preparatory works for drilling.	l	No		
4	Stand by time		Hr		
5	Shifting of the drilling unit between sites	30	Km		
<b>Drilling of Well 420 mm diameter</b>					
6	Drilling/Reaming from 0 to 30 m below ground level	30	M		
<b>Drilling of Well 304-280-254mm diameter (Fractured or consolidated formation)</b>					
6.1	Drilling from 30m to 60m BGL	30	M		
6.2	Drilling from 60m to 90m BGL	30	M		
6.3	Drilling from 90m to 120m BGL	30	M		
<b>Drilling of Well 215-203mm diameter in Hard rock</b>					
6.4	Drilling from 50m to 100m BGL	5	M		
6.5	Drilling from 100m to 150m BGL	3	M		
6.6	Drilling from 150m to 180m BGL	30	M		
<b>Drilling of Well 175mm diameter in Hard rock</b>					
6.7	Drilling from 120 m to 180 m BGL	5	M		
6.8	Drilling from 180 m to 200 m BGL	5	M		
<b>Installation of Temporary casings - 304 -280- 254 mm diameter</b>					
7	Installation and removal of 303/280/254 mm temporary casing	25	M		
10.4	Supply and install 7" / 180 mm ASTM D 1785 SCHD-80 UPVC Plain Casing Pipe with Minimum wall thickness of 10.97mm, flush joint.	54	M		
10.5	Supply and install 7" ASTM D 1785 SCHD-80 UPVC Machine slotted screen Casing Pipe with Minimum wall thickness of 10.97mm, flush joint.	12	M		
9	Drilling Data / Lithological Sampling	l	<b>No</b>		
10.6	Supply and Installation of gravel pack. 50kg	100	Bag		
10.7	Supply and Installation of Inert backfill	l	No		
10.8	Casting of a sanitary seal	l	No		
10.9	Well development	3	Hr		
10.10	Protection cage (800mm *600mm*600mm)	l	No		
10.11	Standard Concrete platform (1:2:4 ratio mix)	<b>No.</b>	l		
10.12	Installation of Ull pedestal with padlocked cover plate or Protection steel casing pipe (over 200mm diameter with cap)	No	l		
10.13	Clearing site	l	No		
10.14	Engraving of well parameter	l	No		
<b>11</b>	<b>Test Pumping:</b>				
11.1	Movement	Km	30		
11.2	Test Pump Installation and Removal	No	l		

11.3a	Step tests,		4.5		
11.3b	Pumping –Constant Discharge Test –Time	Hr	72		
11.4	Recovery Time	Hr	4		
11.5	Water sampling	No	1		
12.0	Water Quality analysis	No.	1		
<b>A - Provisional – Mud Rotary</b>					
A-1	Mud Rotary Bore 410 mm to 254 mm Diameter 0 to 100 m depth using bio degradable formation stabilizers and polymers	1	M		
A-2	Mud Rotary Bore 355 mm to 254 mm Diameter 100 to 200 m depth using bio degradable formation stabilizers and polymers	1	M		
A-3	Mud Rotary Bore 302 mm to 225 mm Diameter 200 to 300 m depth using bio degradable formation stabilizers and polymers	1	M		
A-4	Drilling from 120 m to 150 m BGL	1	M		
A-5	Drilling from 180m to 200m BGL	1	M		
A-6	Supply and install UPVC 8"/203 mm flush joint ASTM 1785 SCHD 80 12.70 MM Thickness from ground level to 100m BGL	1	M		
A-7	Ditto from 100 m to 200 m BGL – 6"	1	M		
A-8	Ditto from 200 m to 300 m BGL – 6"	1	M		
A-9	203 mm ND x 3.0 m long uPVC machine slotted screen	1	M		
<b>PROVISIONAL ( SPECIALISED PUMPING TESTS – FOR HIGH YIELDING WELLS: Q &gt;50m<sup>3</sup>/hr)</b>					
A-10	Test Pump Installation and Removal for high yielding boreholes(Hydraulic winch )		No		
A-11	Pumping Time: power generator 50 KVA to 82.5 KVA -3 phase, mounted on a self-loading 4x4 truck and submersible pump of flow rate 60 m <sup>3</sup> /h to 100m <sup>3</sup> /hr at a head of 50 to 75 meters, with 2½" or /3" outlet.		hr		
A-12	Provisional for Compressed Air boosterup to 1000PSI		Hr		
	Summary				
	Preliminaries				
	Add 18% VAT				
	<b>TOTAL</b>				

**BOREHOLE**  
**Completed in triplicate (3)**  
**COMPLETION REPORT FORM C**

**WATER POINT INFORMATION**

**1. IDENTIFICATION AND LOCATION DATA**

Type of water point:  Borehole:  Dug well:  Augered shallow well:  
 Identification: DWD No: ----- Latitude; E: ----- N:----- Altitude (m):-----  
 ----  
 Location: -----  
 District: ----- County: -----Sub-county: -----  
 Parish: ----- Village: -----Water point: -----  
 Water point ownership:  Private:  Communal:  Institutional  
 Water point use:  Domestic  Irrigation:  Livestock:  Industrial:  
 Water point abandoned:  Low yield:  water quality:  Technical:  
 Date abandoned:

**2. SITE SELECTION DATA**

Site by: Organization: ----- Name of person: -----Title; -----  
 ----  
 Date site----- method of site selection: -----  
 Electromagnetic: -----  
 Seismic: \_\_\_\_\_ Other, specify: \_\_\_\_\_ None: \_\_\_\_\_

**2.0 Attach site selection results**

**3. CONSTRUCTION DATA**

Contractor: ----- Drilled by: Name of person; -----  
 Title: -----  
 Method of construction:  Air rotary  Cable tool:  Mud rotary:  
 Augered:  Dug:  other, specify:  
 Date for completion of construction: -----  
 Total well depth at date of completion (m): -----  
 Water well diameter: mm ----- From; ----- to: -----

----- From: ----- to: -----

Permanent casing/well ring diameter: mm: \_\_\_\_\_

Permanent casing/well ring material: ( ) PVC: ( ) Mild steel:

( ) Concrete: ( ) Bricks:

( ) Other: \_\_\_\_\_

Borehole sealing: ( ) None: (✓) Cement: ( ) Bentonite: ( ) other,

Filter slot size & intervals: mm: From: \_\_\_\_\_ to: \_\_\_\_\_

Borehole filters: ( ) Gravel pack: (✓) Natural pack:

Well development: Duration (hrs): \_\_\_\_\_

Method of development: (✓) Air lift: ( ) Bailed: ( ) Compressed air:

( ) Other (specify): \_\_\_\_\_

**4. INSTALLATION DATA**

Type of pump: ( ) Submersible pump: ( ) Centrifugal pump: (✓) Hand pump: ( ) Bucket:

( ) Other

Date of pump installation: day/month/year: \_\_\_\_\_

Name of pump: \_\_\_\_\_ Pump capacity: \_\_\_\_\_

Pump installation/intake depth: -----

Riser pipe material: ( ) Galvanized iron: ( ) Stainless steel: ( ) PVC: ( ) other

Riser pipe diameter: \_\_\_\_\_ mm

Pumping rod material: (✓) Galvanized iron: ( ) Stainless steel: ( ) Wire: ( ) other

Pumping rod diameter: \_\_\_\_\_ mm

**5. HYDROGEOLOGICAL DATA**

Depth to bedrock: m b.g.l.: \_\_\_\_\_

Overall geological setting: -----

Lithology: (M b.g.l.) From: to:

From: to:

From: to:

From: to

From: to

Water strike, Aquifer and yield:		
<b>Water strike (m.b.g.l)</b>	<b>Aquifer</b>	<b>Yield m<sup>3</sup>/h</b>

**6 YIELD TEST, FLOW AND WATER LEVEL DATA**

Test carried out by: Organization: ----- Name: ----- Title: -----			
Date of test: _____		Duration of test: _____	
<b>A. Step pumping test :</b> ( ) Yes / ( ) No			
Step	Yield (m <sup>3</sup> /h)	Drawdown (m)	Spec. Capacity (m <sup>3</sup> /h/m)
1	_____	_____	_____
<b>B. Constant discharge:</b> ( ) Yes / ( ) No			
Average discharge during test (m <sup>3</sup> /h) _____		Static Water Level, SWL (m.b.g.l) _____	
Date measured _____			
Pumping water level (m b.g.l) _____		Drawdown (m): -----	
Transmissivity (m <sup>2</sup> /day) _____		Spec. Capacity (m <sup>3</sup> /h/m) _____	
Hydro-fracturing: ( ) Yes / ( ) No. If yes day/month/year _____			
<b>C. Natural flow:</b> ( ) Yes ( ) No			
<b>D. Air Lift test:</b> ( ) Yes ( ) No			
<b>Attach pumping test results.</b>			

**7 HYDROCHEMICAL DATA**

Date of Sampling:-----

Method of sampling; pumping, ( ) airlift, ( ) bucket, ( ) other ( specify)-----

Sample preservation;

Analyzed by : Name..... Organization:.....

**Data sheets attached**

**8. OTHER INFORMATION (include information not catered for in the above sections)**

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**9. DETAILS OF ORGANISATION SUBMITTING DATA**

Name: _____
Address: _____

Telephone Number: \_\_\_\_\_.

E-mail:

Name of responsible officer:

Title: \_\_\_\_\_.

Signature: \_\_\_\_\_.

Date of data submission:

Stamp of organization

Project No		Location	Source Name	
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## DEEP WELL LOG

<b>Project Name</b>		<b>Borehole No:</b>		<b>Page of</b>
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<b>DRILLING SPECIFICATIONS</b>										
DEPTH (Mbgl)		Actual bit diameter	Bit type/ Nominal size in mm				Drilling method			
From	To	(mm)	tricone roller	Drag	Button	Odex	Air	Mud	DTH-Hammer	Odex

<b>LINNING INSTALLED</b>						
<b>Length of casing above the ground (m)</b>						
Depth(Mbgl)		Diameter (mm)	casing/screen	material	slot size	Remarks.
From	To	inner/outer	C or S	PVC Steel	(mm)	Plain, Ribbed, Continuous
		/				
		/				
		/				
		/				
		/				
		/				
		/				
		/				
		/				
		/				

<b>FILLING</b>							
Depth (Mbgl)		Gravel pack size	Backfill Material	Type of Seal		Packer	Bottom plug.
From	To	(mm)		cement	bentonite		

Signature supervisor.....  
 1 Actual size, measure the actual size and record in mm  
 2 Nominal size, size of bit when new.

Project Name		Well No		Page	of
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**PENETRATION RATE**

**LITHOLOGY**

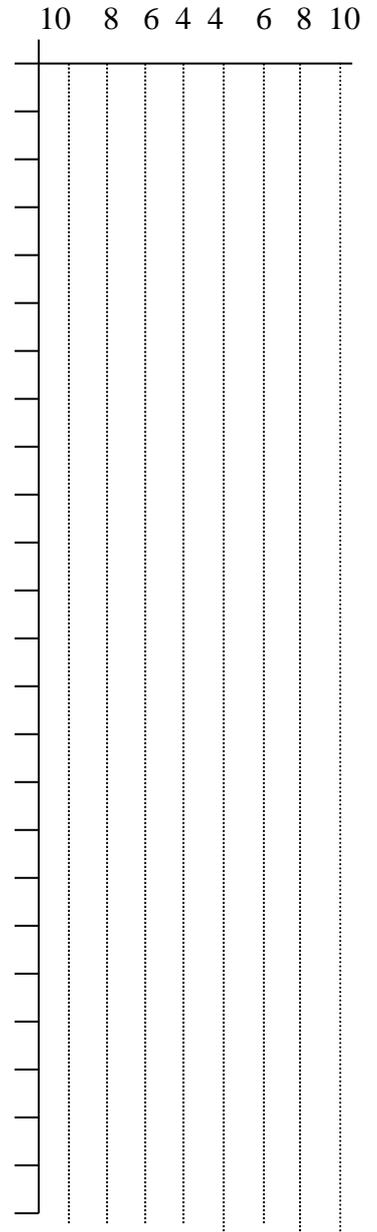
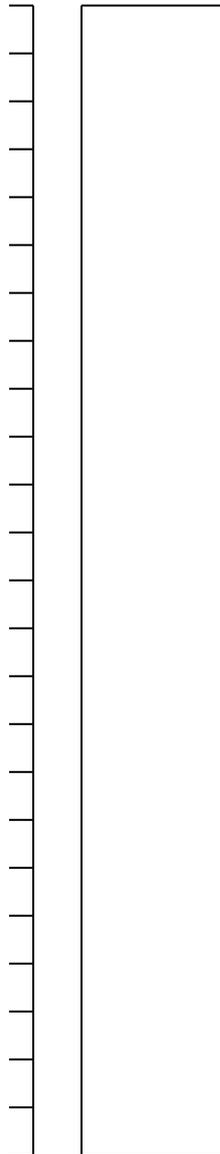
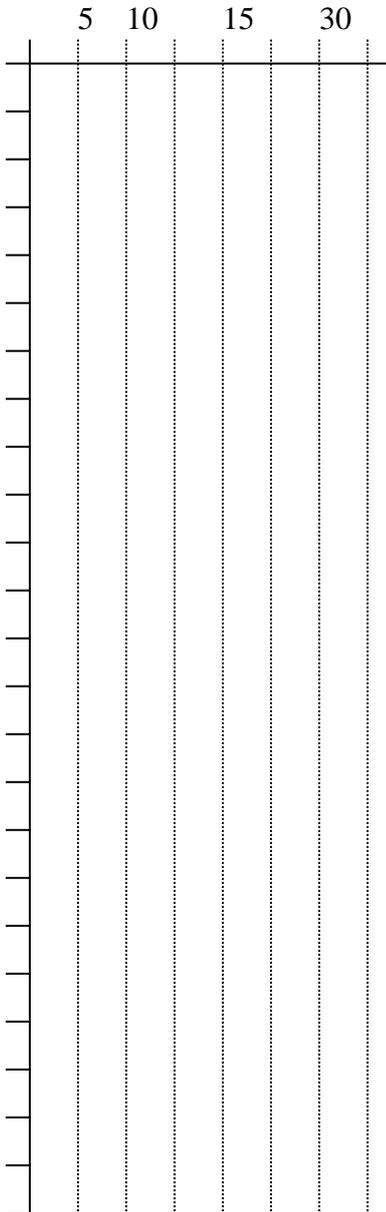
**WELL DESIGN**

**METER PER MINUTE**

Time (min)

Description/H<sub>2</sub>O strikes

Diameter in inches



**EVALUATION REPORT.**

Project Name		Borehole No.		Page	
Project No		Location		Driller's Yield (M3/H)	
Date Start		Parish		Contractor	
Date End		Sub/County			
Source Name		County		Driller/Unit	

Depth		District		
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<input type="checkbox"/> successful source <span style="float: right;"><input type="checkbox"/> Failed Sources</span>
<p>Geophysical data compared to drilling.</p> <p>Problems &amp; solutions encountered during drilling.</p> <p>Cause of failure if applicable.</p> <p>Recommendation for future drilling.</p>

<p><b>ASSESSMENT OF CONTRACTORS PERFORMANCE.</b></p> <p>Availability Of Necessary Tools, Trucks And Equipment</p> <p>Arrival Time On Site:</p> <p>Down Time(Hours):</p> <p>Cause Of Down Time(Mechanical, Fuel, Staff, Tools, Roads)</p> <p>Frequency Of Breakdown:</p> <p>Early Communication To Project On Breakdown:</p> <p>Acceptance Of Instructions;</p> <p>Following Instructions And Technical Specifications:</p> <p>Timely And Correct Entry Of Records;</p> <p>Communication Skills And Discussion Of Issues</p> <p>Formation Collapse In Drilled Hole(M)</p> <p>Drilling Pace Relative To Plans</p> <p>Use of protective gear by crew at site.</p>
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