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Bid document/Terms of Reference (ToR) for Tendering

Contracting drilling contractors of any category/level to conduct the Drilling and construction of Deep well including supplying and installing all electro-mechanical equipment/ parts(solar pump and solar panels) at Kalle Golba kebele in Delo Mena woreda Bale zone Oromia Regional state

1. BACKGROUND

Ethiopia is one of the Sub-Saharan African countries most seriously affected by environmental problems such as land degradation. In order to reduce these impacts, the Government of Ethiopia (GoE), in collaboration with its development partners, has been implementing the Sustainable Land Management Program (SLMP) since 2008. The German Government via Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and Kreditanstalt für Wiederaufbau (KfW) has been supporting the Ethiopian Government's efforts with the SLMP from the very beginning, GIZ more particularly with the Sustainable Land Management Program (GIZ SLM) operating in the country's highland regions and with the Strengthening Drought Resilience Program (SDR) which focuses on pastoralist lowland areas. In early 2016, the Federal Democratic Republic of Ethiopia and the European Union (EU) agreed to launch a new support program to SLMP under the title "EU Support to the Sustainable Land Management Program in Ethiopia" (EU Support to SLMP). The action is fully harmonized with the GoE's SLMP results framework, builds on the ongoing SLMP and the aforementioned German Development Cooperation programs and is implemented by GIZ and KfW.

"EU Support to SLMP" is fully harmonized with the GoE's SLMP results framework, contributing to both, the development goal and the environmental goal of the overall objective, namely:

Development goal: "Improve the livelihoods, food security and economic wellbeing of the country's farmers, herders and forest resource users." Indicators:

- Change in rain-fed crop land productivity in SLM investment areas for three major regional crops (t/ha)
- Change in livestock productivity in in SLM investment areas (liter milk/day)
- Number of direct beneficiaries disaggregated by sex

Environmental goal: Rebuild Ethiopia's natural capital assets by overcoming the causes and mitigating the negative impacts of land degradation on the structure and functional integrity of the country's ecosystem resources. Indicators:

- Land area restored or reforested/afforested on both individual and communal land (Ha)
- Land area with sustainable and climate-smart/resilient land management practices (Ha)

"EU Support to SLMP" will focus on three main components/outcomes:

Outcome 1: Smallholder farmers and communities in the selected watersheds/districts adopt and scale-up appropriate sustainable land and water management technologies and practices.

- Land users adopting at least three sustainable and climate-smart/resilient land management practices on individual land disaggregated by sex (# and %)
- Increased area under irrigation in the micro watersheds (Ha)
- Share of micro watersheds, where user groups apply sustainable natural resource management bylaws (%)
- Constructed community and SWC infrastructures sustainably managed by communities (%)
- Individual farmers/user group members involved in SLM based income-generating activities disaggregated by sex (#)

Outcome 2: Capacities, knowledge and skills of key stakeholders (communities, public and private service providers) involved in natural resources management are strengthened.

- Farmers' and development agents' satisfaction with trainings received under SLMP and able to apply the skills and knowledge gained (# and %)
- A context specific SLM approach for the lowlands is developed (#)

Outcome 3: Effective program portfolio management and coordination at the federal, regional, zonal and district levels has been established and operationalised.

- Share of planned versus achieved activities and budgets (%)
- Frequency of SC and coordination meetings at different levels
- Districts with M&E systems (also gender sensitive) that are contributing accurate data up to SLM program level M&E (# and %)

"EU Support so SLMP" will be implemented in eleven woredas located in two different eco-regions in Oromia region: five woredas are found within South Eastern Bale Eco-region, adjacent to Bale Mountains National Park (Dinsho, Goba, Harena Buluk, Dello Mena and Berbere), while six woredas are located in Yayu Eco-region close to Yayu Forest Biosphere Reserve (Bacho, Yayu, Dorani, Hurumu, Alge Sachu and Bilo Nopha). While eight woredas are considered typical highland woredas (Bacho, Yayu, Dorani, Hurumu, Alge Sachu, Bilo Nopha, Dinsho, Goba), three woredas in Bale are characterized as transitional/lowland woredas (Harena Buluk, Dello Mena and Berbere). In these transitional/lowland woredas, "EU Support to SLMP" will support the piloting of context specific measures and will support in of construction different rural infrastructures.

2. OBJECTIVES

Against the above-mentioned background, "EU Support to SLMP" is tendering to contract potential drilling contractors of any category/level who have experience and related skill to perform drilling and construction of Deep Well (DW) including supplying and installing all electro-mechanical equipment/units(solar pump and solar panels) at Kalle Golba kebele in Delo Mena woreda of Bale zone Oromia regional state to:

- To mobilize resources required for the construction in the agreed period
- To implement and complete quality drilling and construction of one (1) Deep Well and handing over to client/employer within the agreed period.
- Supply and install all electro-mechanical equipment/units (pump, solar energy panels with all essential accessories)

3. SCOPE OF SERVICES

General:

GIZ EU Support to SLMP wants to contract out water well drilling, well construction, well development, and different testing as well as supplying and installation of all electro-mechanical equipment works in Kalle Golba kebele Delo Mena woreda of Bale Zone Oromia region. The depth of the borehole is up to 200m and method of drilling varies based on the geological setting. Therefore, the contractor to be awarded the contract is expected to supply capable and appropriate drilling machine and qualified personnel to complete the work within the intended completion time.

The responsibility of the employer is to get site access permission from local administration and assign site supervisor.

The requirements of the work are as follows:

1. Drilling of production wells with the diameter and to the depth specified in the BOQ,
2. Supply and installation of surface and well casings, screens, observation pipe, filter pack, development, test conduct pumping test and well head construction as necessary,
3. Water and aquifer sampling for the well drilled,
4. Disinfections and securing of all wells using an appropriate method on completion of construction,
5. Preparation of factual reports for the borehole detailing the work carried out and the results obtained,
6. Supplying and installing elector-mechanical units (pump and solar panels) for energy source of pumps
7. All other associated and ancillary works

4. LOCATION

Kalle Golba kebele is located in Oromia regional state, Bale Zone Delo-Mena district, at distance of 589 km, 159km, and 34 km from Finfinne, Robe town (Zone capital city) and Mena town (district city) respectively. The UTM Location is 617208 E, 714384 N, and their altitude is 1130m above sea level in kebele administration office.

4.1 Geology

4.1.1 Regional Geology

Regional geology of the study area is categorized under Tertiary volcanic rocks (Arsi and Bale basalts). The Arsi and Bale basalts are overlain by Quaternary volcanic rocks. The Tertiary basalt (older basalt) may extend to depths and then proceeded by Mesozoic limestone.

Major geologic structures of the rocks are fracture, joints & minor faults. Generally, geomorphology of the area is resulted from Tertiary volcanic eruption and continuous erosion occurring on it.

4.1.2 Local Geology

Redish to dark clay soils is the major soil cover which is resulted from the under laying volcanic rocks or basalts. The observed rock outcropping in the area is a volcanic rock mainly basalts. Those basalts are jointed, fractured and weathered as observed from exposures at places such as river banks. As reviewed from a previously drilled well completion report the volcanic basalts cover only the upper 35 meters and then the Mesozoic sedimentary rock mainly limestone precedes the upper volcanic rock. ***For further information refer design document.***

4.2 Hydrogeology

The vision for groundwater sources in the study area mainly depends on general lithological characteristics, availability of groundwater recharge, and the general geomorphological setup of the region.

The fractured and weathered volcanic rocks are permeable along fracture lines and weathered sections and hence they can store and transmit groundwater and develop water bearing formations or aquifers. As stated above the volcanic rocks (mainly basalts) around the study area is fractured and weathered and therefore groundwater recharge can occur through these fracture lines and weathered sections. ***For further information refer design document.***

5. TECHNICAL SPECIFICATION

Well Drilling and Testing Specification

1. GENERAL

1.1 Machinery for construction

There should be important machinery types required for the drilling and construction of deep well which is very essential like appropriate DTH Rotary Drilling Rig with different types of bit, Compressor of 25 bar or more and Booster, Appropriate mud pump, Appropriate Generator(<150KVA,for depth ≤376m depth and ≥150KVA for depth >377m), Submersible pump of Q=10-100 at 200m and Riser pipes, Welding and cutting equipment, Deep meter greater than 300m,Truck, Pickup, Water Tanker (greater than 4m3), Pump testing equipment, Crane Truck of high capacity(5 ton or above), Dewatering Pump. Thus, the contractor should supply those machinery at site.

1.2 Key staff/personnel for the construction

There should be important key staff and professionals required for the drilling and construction of deep well which is very essential like Chief Driller, Assistant Driller, Hydro geologist, Geologist, Driver for Pick up, Driver for Trucks and crane, Welder, Electrician, Plumber and others)

1.3 Contractors Temporary Workshops, offices etc.

Regarding to the Contractor's temporary office and workshop, etc. at site, it is up to the contractor to facilitate and arrange the staff housing, offices, store plant yards and workshop. However, the Employer can facilitate the location where those facilities will be implemented with Kebele officials.

1.4 Sitting of Boreholes

The contractor shall drill the well at the exact location designated by the Hydrogeologist. The Hydrogeologist shall establish the exact location of boreholes in the field using GPS. The contractor should **attach site handing over format** both at the beginning and on completion of the works specified in the BoQ signed by both parties with the well completion report.

1.5 Site clearing & Access to all sites

The employer or the Hydro geologist will obtain the necessary permission for access to the drilling sites, but any access road or bush clearing to provide access to the drilling site and undisturbed construction work will be the responsibility of the drilling contractor. The contractor at his own cost will repair any damage to the surface of any private roads, fences or gates by the contractor's plant and equipment. Drilling mud pits abandoned dry wells & others must be properly back filled and levelled after completion of drilling work. After completion of drilling and construction work, the environment shall be thoroughly cleaned from foreign substances brought to the site during the construction activity. Any other damage to private property will be handled strictly according to the general condition of contract.

The contractor shall dispose of drilling fluid, cuttings, and discharged water in a manner prescribed by the Hydro geologist so as not to create damage to public or private property.

1.6 Outline Well Design

1. The boreholes will be drilled with nominal diameter specified in the BOQ in the over-burden upper section and installed with temporary or permanent, as the case may be, surface casing to protect caving during drilling and for hanging pump in case of borehole completed with PVC well casing.
2. The drilling diameter below surface casing installation depth shall be approximately is as specified in the BOQ. If the borehole is to be housed with casing and screens their positioning shall be instructed in written by the Hydro geologist based on the result of litho logic and electrical log (if conducted).
3. The drilling contractor should avail water level measuring deep meter and record daily the water/drilling fluid level before starting the drilling work. The monitored water level/fluid level data should be attached to the well completion report.

4. A 19mm nominal internal diameter observation pipe will be installed in the annulus with slotted sections opposite screen sections.
5. If written instruction is given by the Hydro geologist gravel pack will be installed in the annular space of the borehole wall and the outer portion of the casings to a minimum of 5m above the static water level.
6. Cement grout shall be applied above the gravel pack in unconsolidated section. Before applying cement grout a minimum of 50cm thick sand bridge shall be placed above the gravel to protect cement infiltration.
7. On completion of testing each borehole shall be secured with 6mm thick steel plate welded to the top of well or surface casing, as the case may be, and well head shall be constructed as per the specification.

1.7 Inventory

Prior to the commencement of work the Hydrogeologist shall have the right to inspect the drilling and pump testing units of the contractor to be assigned for the project. Any items of the inventory rejected by the Hydro geologist/supervisor as being unsatisfactory by reasons of wear, the Contractor will replace inadequacy, unsuitability etc. as soon as possible.

1.8 Materials

The materials to be used for the construction of this well shall meet the following requirements:

1.8.1 Well Casings

If the Hydro geologist orders installation of casings and screens, all casings to be supplied for the construction of the well shall be manufactured of PVC or steel or other ferrous materials (as described in the BOQ), new, seamless, threaded ends and couplings and comply with the standard such as DIN 4920, API and ASTM. Casings can be joined to each other with threaded and coupled joints or by welding. If reinforcing is required for threaded casings after the casings are joined, the joint may be reinforced with welding if the Hydro geologist finds it necessary and gives approval to the contractor. The welding to be used for joining casings is DC arc welder with a rating of at least 250 amperes. The welded parts shall be clean and free of slag. For boreholes with depth up to 150m the well casing and screen to be installed shall be made of PVC and for boreholes above 150m depth the well casing and screen shall be made of steel. But in case the formation penetrated is dominated by caving unconsolidated formation where it is difficult to install PVC casing and screen change might be ordered with written instruction. If the well is completed in fractured and stable aquifer the Hydrogeologist may instruct the contractor to install the whole string of casing and screen assembly to be suspended or hanged on the surface casing at the well head with appropriate flange. In that case, the bottom of the casing should be at least 5m above the bottom of the hole leaving an open space for accumulation of

aquifer materials falling from the wall of the well. For such type of installation, the bottom of the casing should be sealed or plugged and filter packing is not required.

If the well is dry or of low yield both the supervisor and the contractor has an obligation to let the head office know and attend the site before abandoning the well or installing production casing. If not payment might not be approved for dry well or low yielding wells installed with production casing.

Minimum wall thickness for all casing shall be as follows;

Nominal inside diameter	**Minimum wall thickness**
150mm	5.4mm
200mm	6.4mm
250mm	7.8mm
300mm	8.4mm
350mm	9.5mm

1.8.2 Surface casing

The contractor shall drill a well of diameter specified in the BOQ in the upper unconsolidated formation to accommodate the outer temporary (protective) casing of the specified diameter for each well. Temporary surface casings are used to protect caving overburden during drilling and for hanging pumping set and well casing when installed permanently in boreholes completed with PVC well casing or in boreholes not packed with gravel. The diameter of this casing has to be wider than the presumed drilling diameter to allow the drilling bit to pass through to continue further drilling. The top of the outer casing when permanently installed shall be above a known flood levels in the area. The minimum thickness of the surface casing shall be 5mm.

1.8.3 Inner casing

The working (production) casing to be installed shall be manufactured of PVC if the borehole depth is 150m and less or mild steel if the depth is more than 150m. This casing shall have a diameter specified in the BOQ. The casing can be threaded or blank of the aforementioned standards.

1.8.4 Well Screen

The Well screen shall be manufactured of PVC or steel based on depth of the well and shall have a minimum of 10% open area. The slots shall be widening inward to minimize clogging. Johnson Division or an equal if approved by the Hydro geologist shall manufacture the well screen.

If the contractor supplies slotted screens the slots must be factory slotted or made using standard slotting machines, vertical, 100mm in length and the slots around the perimeter of the casing must be equally spaced. The slots should be clean and without cutting residues. Drilled holes or torch cut slots are not permitted.

The screen slot size shall be selected on the basis of a mechanical size analysis of either the natural water-bearing sediments or the filter pack material. The maximum slot opening must be 2.5mm.

Of the total water bearing section 70% should be screened. The screen should extend 1m from top and bottom of the aquifer. The screen should not extend above the draw down level while the well is in production.

Screens of diameter specified in the BOQ shall be installed in the location of aquifer layer based on the findings of well loggings (litho logic and electrical). The Hydro geologist shall give written instruction for the location of well screens. They shall be incorporated into the well casing by threaded ends. Short lengths of well screen can be incorporated at intervals in the casings adjacent to the aquifer to permit the entrance of water into the casing from the rock.

1.8.5 Observation Pipe

Water level observation G.S. pipe should be installed in the annulus of the well to be drilled. The observation pipes shall be ¾" internal diameter. The pipe should be closed at the bottom by a plug. The observation line should reach approximately as deep as the screens of the well. The uppermost slotted section should be about 10meter below the top most screens. Slots must start at about 2m above the lower end of the pipe.

If observation pipe screens are made by hand, slots may be cut with a hack saw. Slots may be arranged on two sides, in an alternating manner, the slot spacing on each side being about 2-3cm apart. Care should be taken that the slots are clean and without cutting residues. Drilled holes or torch-cut slots are not permitted. The observation pipe shall be installed on the outside of the casing and screen column before applying the gravel pack. It must under all circumstances be installed in a rectilinear way to allow the free passing of probes. Non-compliance with this requirement entitles the Hydro geologist to accept the well.

1.9 Gravel Pack

If the Hydro geologist instructs gravel packing, the gravel to be supplied shall be natural well-rounded, smooth and uniform, sieved and washed river gravel, preferably quartz grains. If pure quartz gravel can't be obtained the Hydro geologist may consent to install similar materials. The Hydro geologist based on the size of the aquifer materials shall order and approve the gravel size. ***The maximum allowable non-round particles are 10%.*** The gravel pack must be placed in the annular space between the casing holes starting from the bottom up wards, up to the level instructed by the Hydro geologist depending on the static water level.

To avoid bridging of the gravel, which may lead to severe damages to the casing, screens and to the borehole wall, it is forbidden to fill-in the gravel by mechanized equipment. The gravel must be filled- in by hand, using shovels during well development.

Filling will proceed slowly and carefully during well development. The correct placing of gravel will have to be controlled by continuous recording of the volume of gravel consumed and by repeated measurement of the achieved level of packing.

If the aquifer is unconsolidated and poorly sorted the Hydro geologist might order development of the aquifer formation to attain natural gravel pack and the gravel to be packed must be sieved and washed.

1.10 Supply of Drilling Water

The provision of all water for drilling operation is the responsibility of the contractor. The water to be used for drilling should have the **quality of drinking water.** Therefore, the contractor will be required to make his own arrangements for supply of drilling water of such quality.

1.11 Drilling Methods

The boreholes to be drilled are situated in different geologic environments, which include unconsolidated sediments, slightly to well consolidated rocks, and medium to hard formations. ***Hence, the drilling method to be used shall be that suitable for the local condition i.e. air rotary, DTH or mud rotary or combinations.***

The aquifer will be drilled with a minimum damage from clogging of inter-granular pores of fractures or any other openings, which make up the permeability of the aquifer.

1.12 Well Depths

The drilling depth for the site is indicated in the BOQ. The indicated target depths are estimates hence target depth of drilling could be increased or reduced by 25% depending upon site hydrogeological conditions and hence the drilling Contractor is therefore required to be equipped, accordingly.

1.13 Drilling Diameters

Drilling shall be started or open the ground with diameter specified in the BOQ for the well in the unconsolidated upper section for the installation of surface casings and continued to the final depth with the diameter specified in the BOQ. ***The drilling diameter however may change according to the geological situation during actual drilling. Changes shall not be made unless otherwise the Hydro geologist feels/suggests changes are necessary and gives written*** instruction

1.14 Geological Logging

Drilling cuttings shall be collected during the drilling operation and kept in a sample box and handled in a manner that they can easily be identified. Samples shall be taken at predetermined intervals of 1m and whenever there is a change in formation type.

1.15 Geophysical well Logging

Geophysical well logging shall be conducted for the drilled well. The type of logging shall be determined based on the need of site-specific condition information. Most commonly Electrical (resistivity) logging shall be conducted in drilled wells to determine the aquifer position in the well as deemed necessary by the Hydro geologist. Casing arrangement shall be based on the litho logic and electrical log result.

1.16 Plumpness and Alignment

Upon completion of lowering of casings or at any other time requested by the Hydro geologist, the drilled boreholes shall be checked for verticality and straightness using deviation measuring instruments like **Inclinometer**, **Draft indicator**, etc. Running a dummy down the casing may also check the alignment. The dummy shall consist of a cylinder 10m in length with a diameter 20mm less than the well casing. The dummy must pass freely through the entire length of the cased borehole. The contactor may also conduct these and any other tests when he may deem necessary to satisfy himself that the borehole is being drilled plumb and straight. ***These tests shall be made entirely at the contractor's expense***. If the hole is out of alignment as determined by the dummy or more than 1% out of vertical, then the hole shall be abandoned and re-drilled.

1.17 Well Development

The term well development means the work carried out after completion of the construction of a well and prior to pumping test. The objective of development is to improve well performance, to increase well capacity and to reduce an unacceptable level of the amount of sediment contained in the water yielded by the well. In a few cases further development may be required after testing.

The development of the well shall remove the native silts and clays and drilling fluid residues deposited on the borehole face and in adjacent portions of aquifer during drilling process. Development shall also remove a predetermined finer fraction of filter pack. If organic drilling fluids are used, it must be broken down chemically according to manufacturer's recommendations before or during development.

Based on the drilling method applied different types of well development could be applied such as air lift, backwashing, surging, jetting, reverse circulation, double tube, over pumping, etc. If the drilling is conducted using air rotary or DTH borehole development must be using an air lifting technique. ***The work must continue until the Hydro geologist is satisfied that the borehole, gravel pack and adjacent aquifer have all been adequately cleared of drilling fluid, aquifer fines and drill cuttings and a satisfactory yield has been attained. If rotary drilling is used the contractor shall use standard bentonite with precautions so as not to damage the aquifer. Sodium tri-polyphosphate or equivalent for grade chemical shall be used to breakdown the betonies.***

If the aquifer is damaged and not free from bentonite during development by extending the development hours by 25% the contractor is fully responsible for the development hours beyond

the extended 25%. The contractor is responsible for any defect that may result from his work and shall be corrected on his own cost.

1.18 Well Disinfections

After drilling, wells should be disinfected to make sure that no bacteria, viruses and other pollutants are remaining in the well, which may have entered the well during drilling and construction works. The well shall be disinfected after installing the pump testing set into the well and before collecting any samples for determining microbiological quality. This shall be done by placing a chlorine solution into the well so that concentration of at least 50mg/l of available chlorine exists in all parts of the well at static conditions. All the well surfaces above the static level shall be completely flushed with solution. ***The solution shall remain in a well a minimum of 2 hours before commencing to pump the well.***

1.19 Pump Test and Accessories for Aquifer Test

1.19.1 Pumps and other Equipment

Electrically powered submersible pumps, fitting in to a casing of diameter specified in the BOQ and with capacity to be specified at the end of drilling should be available on site, to carry out pumping test. All equipment shall be reliable for periods of 36 hours of continuous operation at the designed rate.

1.19.2 Generators

The contractor must be equipped with generator sets with a capacity to drive the submersible pumps, welding machines and all power requirements. The generator set should be capable to operate for a minimum of 36 continuous hours.

1.19.3 Water Level Gauges

The contractor should have on site electric sounding device suitable for a maximum depth of 300m. The devices should fit into the ¾" observation pipes and should permit direct, convenient and accurate reading of depth of static and dynamic water levels.

The water level measuring electrical sounding device should be available on site starting from day one of the drilling operation so as to monitor the water level/drilling fluid level on daily basis.

1.19.4 Discharge Meters

A 90^0 rectangular V-notch weir shall be installed on the end of the pump discharge line to determine the discharge rate. A control valve shall be installed so that the discharge rate will not vary more than 5% from the average rate. The hydro-geologist shall approve the equipment and installation. Possibility of checking and calibrating the equipment must be provided. The use of barrel for discharge measurement is not allowed.

1.19.5 . Pumping Test Unit

If, bailing or preliminary pumping test shows that the well has sufficient capacity to be of interest, pumping test shall be carried out. The pumping test unit shall consist of well experienced crew, a submersible pump, a diesel powered generator to run the pump, pipe on which to set the pump and all necessary tools and equipment to carry out pumping tests with an accurate measurement of water discharge and water level in the well. The equipment and crew shall be capable of performing a step draw down test for up to 6 hours and a constant discharge test for up to 24 hours. ***The capacity of the submersible pump to carry out pumping test shall be ordered by the Hydro geologist based on the borehole yield estimate at the end of drilling.***

1.19.6 Well Testing

Special importance is attributed to this phase of the work. The contractor will proceed with utmost care, by assigning qualified and experienced personnel and shall use reliable and accurate equipment. The tests will presumable be performed according to non-equilibrium methods in several stages, each with a specified constant and sustained discharge. No interruption of the test will be tolerated. After having measured the static water levels, a step draw down tests should commence with the lowest discharge stepwhich is $1/4^{th}$ of the estimated well yield. The test should run for maximum of two hours followed by by the 2^{nd}, 3^{rd} and 4^{th} steps. During or after the test the Hydrogeologist will decide upon, following the results, whether the test is satisfactory, or a further development is required, to be followed by a new test.

After the well has fully recovered and allowed to rest for a short period of time, a constant discharge tests will subsequently be run, followed by the recovery test. In the case where stabilization of water level cannot be obtained, the Hydrogeologist may have to decide to extend the duration of the test period. Test can't be terminated without written instruction of the Hydrogeologist.

In case the Hydrogeologist demands provisional pumping test to be carried out in open well or after installation of casings and before gravel packing, the contractor will perform the test accordingly. Payment shall be made only for installation and removal of casings if the well yield is found unsatisfactory. A failure to remove the casings is to the expense of the contractor. ***The contractor is also responsible for installing casing in dry or very low discharge wells. A well is said to be productive if the yield is more than 5l/sec for towns and for rural water supply if yield is more than 2 l/sec. If the contractor estimates the discharge to be less than the specific discharge the contractor should receive written instruction from the contracting party.***

If pumping test is conducted in a well field, during pumping in the tested well, the water level in the remaining wells will be observed. In case there is interference, an interference test is to be performed simultaneously with the constant discharge test, with draw down and recovery measurements taken in all wells. The Hydro geologist shall decide whether a satisfactory stabilization has been obtained in all wells and whether an additional test is to be performed, this time with the observed well pumping and the pumping well as an observation one.

Discharge must be accurately adjustable by means of an easily handled valve. Discharge will be measured by an orifice installation on the discharge pipe, by a water meter or by a V notch with and accuracy of at least 1% possibility for the check up and calibration by means of a tank must be provided. In case the orifice installation will be used a continuous discharge adjustment will be taken care of by means of the valve.

During testing the temperature of the pumped water will be measured at regular intervals. Also during testing, water samples should be taken from the pumped water.

1.19.7 Pumping Test Duration and Measuring Frequency

Three kinds of tests might be carried out:

1. 4 - step-draw down discharge tests
2. Constant discharge tests until stabilization of water level is achieved.
3. Simultaneous/group tests
4. Recovery test

During each test the pumps should operate without interruption. In case of interruptions, caused by negligence or technical defects, a repetition of the respective test may be ordered at the contractor's expense.
Draw down measurements can be but not necessarily, made in the following time intervals:

Time from Pumping start	**Time intervals**
0 to 5 minutes	0.5 minutes
5 to 60 minutes	5 minutes
60 to 120 minutes	20 minutes
120 to shut down of pump	60 minutes

This schedule holds good for each discharge step of the 4-step-draw down discharge tests as well as for the constant discharge tests. The discharge rates should be controlled and adjusted carefully and readings should be made together with the draw down measurements. Water level recovery measurements following the final shutdown of the pump, after the completion of each discharge step and after the continuous discharge tests, should be made in the same time intervals as cited in the table above.

1.19.8 Disposal of Pumped Water

The pumped water must not be allowed to re-infiltrate in the vicinity of the wells. The water should be disposed of by means of discharge pipes towards a nearby natural overland drainage (stream, river). Pools should not be allowed to form. Improper discharge water disposal may result in a non-acceptance of the pumping test.

1.19.9 Defective works

In conformance with pertinent clauses of the contract conditions acceptance of a test may be refused in case of:

- Interruption of test

- Unacceptable variations of discharge
- Incomplete or inaccurate measurements and observations
- Missing samples
- Improper development of the well

1.20 Water Sampling

Water samples have to be taken from the pump discharge for laboratory analysis. The sample should be taken in containers, which have been washed twice with the water to be sampled. The bottles should be clearly marked, showing: name and number of well, date of sampling, hour of sampling and signature of person taking the sample.

Samples will be stored in cool place and delivered to the laboratory in the shortest time possible for chemical, bacteriological, and physical analysis of water.

If water samples show that the water is not of suitable quality for domestic use, the exploratory hole may be abandoned, and the contractor shall be ordered to recover the casings.

1.21 Capping the Well

After completion of the pumping test and removal of the test pump unit, and after the last water level recovery observation have been made, wells shall be securely welded to the top of the surface or production casing as the case may be with steel plate of 6mm thickness to prevent illegal access to the well. An appropriate socket and plug for the observation pipe must also be installed.

1.22 Grout Seal

The annular space between the preventive and production casing shall be sealed with mixture of Portland cement and water slurry by a pour in method from the top for sanitary protection in case the surface casing is permanently installed. In case the temporary casing is to be removed the annular space between the borehole wall and the well casing has to be sealed with mixture of Portland cement and water as described above. Before grouting a minimum of 50cm bridging sand followed by clay plug of 6m or more shall be placed over the gravel pack in order to avoid cement infiltration into the gravel. Cement grout should not be placed before the end of the pumping test to allow the gravel to settle and be filled up as necessary.

1.23 Well Head

Constructing wellheads around the casing must complete for the successful wells. The surrounding of the well casing must be excavated until reasonable firm foundation is obtained for wellhead construction. In case firm foundation is not available close to the surface the space around the casing shall be excavated to a depth of 1.50m and filled with concrete. The concrete wellhead in C.25 will have a dimension of **1x1x1.5** meter and

must be bedded **0.5 m** above the ground surface. The casing shall protrude a minimum of 0.2mt above the concrete block unless and otherwise specified by the Hydro geologist. ***In addition to this, the boreholes (BH) must be tagged on well head by casting with cement mortar containing the following information.***

1. ***Bore Hole (BH) depth, 2, Bore Hole diameter, 3. casing diameter, 4. year and month of drilling, 5. Discharge 6. Static water level (SWL) and dynamic water level (DWL) 7. Pump position***

1.24 Miscellaneous Equipment

Miscellaneous Equipment for pertinent measurements and observations, e.g. welding and cutting equipment with an electric welding plant with a minimum welding current of 180A in good working order, cutting equipment, stop watch, thermometer, pressure gauge (in case artesian conditions are encountered) sediment cones, PH- paper, containers for water samples must be provided and be on site.

1.25 Special Requirements

1.25.1 Recovering of the installed Casings

Casing and screens from unsuccessful wells will be recovered by pulling using the hoist line on the drilling rig or an appropriate hydraulic jack. It is to the contractor expense, if unable to recover casings from unsuccessful wells. Payment shall be made only for the installation and removal of casings for the unsuccessful wells.

1.25.2 Fishing for Lost or Stuck Tools and Equipment

Fishing will be done using the most appropriate techniques and fishing tools, in order to minimize the time required for fishing and with minimum damage to the hole and to the items being fished, standard fishing tools as well as special tools fabricated on site or in a shop may be used. In a situation where drilling tools and equipment are lost or stuck in a hole, the Hydro geologist's Representative shall decide whether it is in the interest of the Employer to carry out fishing operations in order to salvage a hole or for any other reason. If, in the opinion of the Hydrogeologist, it is not in the interest of the Employer to carry out fishing operations, the contractor may fish to recover tools and other equipment at his own, without creating any delays to the Employer's time schedule.

1.25.3 Work Sheet and Records

During drilling and testing the contractor will keep records on printed forms, penetration rates, litho logy, drilling problems encountered, draw down, discharges, temperature, etc. The drilling and pumping test and recovery sheets should be filled -in accurately and should contain remarks on all irregularities observed and other information which may be of interest for future drilling in the area and the assessment of the tests (e.g. remarks on water odor, taste, color, suspended matter, etc.) Technical failures and irregularities should

likewise be mentioned. Work sheets for each drilling unit will be prepared in English by the contractor hydro-geologist for each shift. The work sheets will be prepared in duplicate and signed by the contractor representative and the Hydrogeologist. The Hydrogeologist will retain the original. The work sheets will include the following information.

a. Drilling

1. The location of the drilling site, name of well,
2. Make, model, type and size of drilling rig,
3. Date of commencement and completion of drilling,
4. Type of work performed including mobilization, demobilization and on site relocation and number of hours on each type of work,
5. Name of all crew members,
6. Size of hole and depth penetrated,
7. Log of formation penetrated,
8. Length and size of casing installed,
9. Length and size of screen installed,
10. Length and size of observation pipe installed,
11. Any problems encountered,
12. The result of bailer tests or other tests carried out,
13. Total drilling time in hours, Drilling, as here in defined, includes drilling, installation and removal of casings, bailing, screen installation, water sampling, well development and fishing for lost or stuck tools and equipment when ordered by the Hydro geologist's Representative,
14. Total stand by time in hours. Standby is here by defined as time when no drilling is in progress due to delay ordered by the Employer, the Hydro geologist or the Hydro geologist's Representative,
15. Total time in hours lost due to break down, shortage of labor or materials or for any other reason that is the responsibility of the contractor,
16. Length in meters of casing recovered
17. Time spent fishing on the contractor's time
18. Materials stockpiled on site including those supplied by the contractor and those supplied by the Employer, if any.

b. **Test pumping**

1. The location and name of the well being tested. Physical characteristic of the well including depth, diameter, size of casing screen setting and length of screen,
2. Date of commencement and completion of pumping test,
3. Type and capacity of pumps used,
4. Type of work performed and number of hours on each type of work including mobilization, demobilization or on site relocation
5. Position of pumps,
6. Total test pumping in hours. Total time charged must agree with pumping test data sheets. Chargeable time for test pumping is from the start of a pump test to the time pumping stops. No payment will be made for tests rendered unsatisfactorily by reason of break down or lack of fuel or for any other reason.
7. Interpretation result of the test which include values of Transmissivity, storativity, hydraulic conductivity, safe yield and recommended pump position
8. Total stand by time in hours, Standby is here in defined as time where no test pumping is in progress due to delay ordered or caused by the Employer or the Hydrogeologist or the Hydro geologist's

Representative. Stand by also includes time when recovery observations are being made prior to the commencement of the removal of the pump at the commencement of demobilization or on site relocation.

9. Total time in hours lost due to break down, shortage of labor or materials or for any other reason that is the responsibility of the contractor.
10. Names of all crewmembers actively engaged in the work.

1.25.4 Protocols and Records

The contractor has to keep exact records on all activities. The following records have to be presented to the Hydro geologist for checking and signing, not later than 24 hrs after the completion of the relevant activities:

- Daily working sheets on drilling
- Well equipment used
- Development
- Test pumping, litho logical borehole logs
- Verticality tests

Field copies of borehole logs and or pumping test data sheets and graphs must absolutely be kept up-to-date. Upon request of the Hydrogeologist the respective graphs and sheets must be updated without delay whenever he visits the site, to give full information on the present situation. Representative samples of the penetrated section must also be taken, kept and shown on request to the Hydro geologist. Clean copies of all information as requested by the contractor conditions and other tender documents must be submitted within one month after the completion of the respective well operation.

1.25.5 Final Reports

After completion of each well (drilling, development, re-development, and pumping tests) the contractor has to submit a final report incorporating all-important result of specific activities. The well report has to contain remarks on all special observations, difficulties, etc. The complete well report must be such that the activities and findings can be reproduced step by step. For the well the final report has to be submitted within one month after completion of all activities in the relevant well.

1.26 Measurement and Basis of Payment

1.26.1 Mobilization and Demobilization

This item in the bill of quantity includes moving all materials, equipment and personnel of the contractor for constructing and developing the well to and from the site. It also includes cleaning up the site before commencing the work and upon completion of the contract. Mobilization and demobilization must be quoted as lump sum at the item provided in the Bill of quantity of this contract document.

1.26.2 Inter site Mobilization

Inter site mobilization shall mean transporting of all contactors' manpower, equipment and plant between drilling site. The Price shall include the complete removal of the necessary drilling equipment, materials and crew from the previous drilling site.

1.26.3 Drilling

Payment for drilling will be made at the unit price per meter shown in the bill of quantity for the various diameters of the borehole. Measurement will be made vertically to the nearest 0.1m from the original ground level to the bottom of the completed hole. This price will include all materials, equipment, labor and all work incidentals thereto except for those items for which payment is specified additionally to that of drilling. No payment will be made for boreholes abandoned or incomplete as a result of lost or stuck tools, stuck casing, failure to meet plumpness or alignment tests, or any other reason that is the fault of the contractor.

1.26.4 Surface Casing

Payment for surface casing will be made at the unit price per meter shown in the bill of quantity for the various sizes of pipe. Measurement will be made to the nearest 0.1m vertically from the top of the casing to the bottom of the casing installed in the completed borehole. This price shall include supply of surface casings, pipes cutting, pipe welding, installation, testing and all work.

No payment will be made for temporary casing, which is installed to facilitate drilling operations and is subsequently to be removed. No payment will be made for surface casing installed in an abandoned borehole as defined in the item above.

1.26.5 Well Casing

Payment for well casing will be made at the unit price per meter shown in the bill of quantity for the various sizes and types of pipe. Measurement will be made to the nearest 0.1m vertically from the top flange of the wellhead to the bottom of the casing in the borehole less any section of screen, which is paid for separately. This price shall include supply of casing, couplings, welding, and installation, testing and all work incidentals thereto. No payment will be made for temporary casing, which is installed to facilitate drilling and is subsequently to be removed. No payment will be made for well casing installed in abandoned borehole as defined in the item above. ***The casing installation as much as possible is lowered to the target (drilled) depth. None installed drilled depth can be allowed (tolerated) by3%.***

1.26.6 Well Screen

Payment for well screen will be made at the unit price per meter shown in the bill of quantity for the various sizes and types. Measurement will be made to the nearest 0.1m from the top of the screen to the bottom of the screen for each section of screen installed in the casing. This price shall include supply of well screens, couplings, welding and installing, testing, and all work incidentals thereto. No payment will be made for well screens installed in abandoned boreholes resulting from the contractor's fault as defined above.

1.26.7 Observation Pipe

Payment for observation pipes, blank and slotted, will be made at the unit price per meter shown in the bill of quantity. Measurement will be made to the nearest 0.1m vertically. This shall include supply, installation, testing and all work incidentals thereto.

1.26.8 Gravel Pack

Payment for gravel pack is made at the unit price per cubic meter shown in the bill of quantity. This price shall include supply, installation, testing, and all work incidentals thereto.

1.26.9 Well Head

Payment for wellheads will be made at the unit price per wellhead shown in the bill of quantity. This price shall include materials, excavation, prefabrication, installation, reinforced concrete, back filling, and drainage, site grading and all work incidentals thereto. It also includes supply and placement of sand and paddle clay seal.

1.26.10 Grout seal

Payment for grouting will be made at the unit price per meter shown in the bill of quantity. Measurement will be made vertically to the nearest 0.1m from the top to the bottom of the completed grouting. This price shall include materials, installations and all work incidentals.

1.26.11 Well Development

Payment for development will be based on the unit price per hour shown in the bill of quantity. It shall cover only those hours the development tools and equipment are actually being operated.

1.26.12 Plumb and Alignment Test

Payment for plumpness and Alignment tests required in writing by the Hydrogeologist will be made at the price per site in the bill of quantity. The price will include materials, equipment and all work incidentals thereto. No payment will be made for tests carried out by the contractor for his own information.

1.26.13 Test Pumping

Payment for test pumping will be made at the unit price per hour in the bill of quantity. Measurement to the nearest minute will be as shown on the test pump data sheets from the time the pump test starts until it is completed. No payment will be made for tests terminated without written instruction of the Hydro geologist. The price shall include materials, equipment and work incidentals thereto.

1.26.14 Monitoring Recovery

Payment for monitoring recovery will be made at the unit price per hour sown in the bill of quantity. Measurement to the nearest minute will be shown on the recovery monitoring data sheets from the time the

monitoring starts until it is completed. No payment will be made for monitoring terminated prior to the time specified by the Hydrogeologist or rendered unsatisfactory.

1.26.15 Test Pumping Standby

Payment for test pumping standby will be made at the unit price per hour shown in the bill of quantity. Measurement shall be made to the nearest minute when test pumping is stopped on orders from the Hydro geologist. Payment will only be made when the test pump is set up in a hole and is fully operational.

1.26.16 Capping the Well

Payment for furnishing and installing the well cap will be based on the lump-sum price shown in the Bill of Quantity.

1.26.17 Electrical and Litho logic Logging

Extra payment shall not be considered for lithological logging but shall be included in the unit prices and lump sums in the bill of quantities. Payment for electrical logging will be made at the unit price per well being logged.

1.26.18 *Pump and its units*

Payment for supplying and installing Submersible pump will be based on the set price shown in the Bill of Quantity keeping and maintain the capacity of 22 kW, 4.18l/s at 345m head. This price shall include Supplying materials (pump and its accessories), installations and all work incidentals. No payment will be made for incomplete installation of pump and its units. Pump (solar pump). The pump and solar equipment shall be supplied from the same manufacturer to have the advantage that the components are ideally matched in terms of technical values / functionality. ***For further information refer design document for pump and solar panel.***

1.26.19 *Solar energy Panels (solar energy to run pump)*

Payment for supplying and installing solar panel will be based on the set price shown in the Bill of Quantity keeping and maintain the **Solar Module of 250wp** with all its accessary fixing and connecting accessories (cables, water and dust proved connection box of IP65 with fuse and positive, negative and ground connection terminals) that suitable for altitude of 1127.5m a.m.s.l. This price shall include Supplying materials (solar panels and its accessories), installations and all work incidentals. No payment will be made for incomplete installation of solar energy panels and its units. ***For further see the design document of solar pump and panels.***

1.27 Final Report

Payment for the well report shall be made as lump sum price as indicated in the BOQ. No payment shall be made for reports found unsatisfactory due to lack of consistency and specific details of works performed.

1.28 Abandoning a well

a. No payment shall be effected for boreholes abandoned without written instruction of the Hydro geologist whether it is dry or of low discharge rate.

b. No payment shall be effected for boreholes abandoned due to collapsing, caving, improper Casing installation, and any other technical frailer that the contractor could not manage to rectify as requested by the Hydro geologist.

1.29 Hand over the completed well

The contractor should manage any drilling problems encountered, while drilling and should properly complete and handover to the employer.

1.30 General Requirements

The Contractor shall engage only those people who have been adequately trained and instructed in their duties. All operators of equipment and vehicles shall be competent and hold all necessary licenses in accordance with current legislation. The Contractor shall employ sufficient numbers of helpers and watchmen who shall guide operators and provide warning of potential conflict with people and other vehicles, as applicable.

The Contractor shall pay due regard to the safety of his workers.

Where appropriate, the Contractor shall pay particular attention to the safety of operators and all persons in the vicinity of fuel transfer / storage operations. A prohibition on smoking must be actively enforced when close to flammable liquids.

All equipment and vehicles shall be in a good and safe working condition. The Contractor must have contingency arrangements in place to attend to personal injuries that may result from accidents occurring within the work site.

1.31 Protection of the Environment / Works

The Contractor shall take all reasonable precautions to preserve the condition of the environment. In particular:

1. No pollutants shall be allowed to enter any watercourse;
2. No unauthorized or indiscriminate felling of trees shall be permitted;
3. No open or uncontrolled fires shall be permitted;
4. The Contractor shall not cause areas of stagnant water to form, on the surface or in open containers;
5. All spoil or waste materials remaining after the works must be neatly disposed of in approved dump sites;
6. The Contractor shall ensure that the Works, including the action of individual workers, do not result in any littering. Where such littering does occur the Contractor shall be responsible for the collection and proper disposal of the litter;
7. The use of herbicides and pesticides shall not be permitted.
8. Excavations, finished works are to be protected from adverse weather and any work damaged by adverse weather is to be repaired by the Contractor.