**Drilling Dynamics and Tubing Specifications**

The boreholes will be equipped with rigid PVC tubing, designed to ensure durability and effective water capture. Key components and specifications include:

1. **PVC Tubing and Strainers**:
   * **Solid Tubes**: Minimum internal diameter of 150 mm, with a wall thickness of at least 15 mm, offering high resistance to shear forces.
   * **Strainers**: Factory-made PVC strainers with a minimum internal diameter of 150 mm, 15 mm wall thickness, and 1 mm slots (9% opening rate). Slot sizes of 0.6 or 0.8 mm may be used depending on the aquifer.
2. **Base of the Column**:
   * Includes a PVC sedimentation tube closed with a factory-made screwed PVC foot cap (height ≤ 10 cm).
3. **Centering and Filter Bed**:
   * Stainless steel centerers will be installed around strainers every 3 meters to ensure even distribution of the filter bed.
4. **Adaptability to Geological Profiles**:
   * The contractor must have various lengths of solid and strainer tubes (1 m, 3 m, and up to 6 m) on-site to adapt to geological conditions.
5. **Average Quantities Per Drilling**:
   * 3 solid tubes (1 m each).
   * 2 strainers (1 m each).
   * 2 solid tubes (3 m each).
   * 2 strainer tubes (3 m each), with additional solid or strainer elements as required.

***PUMPING TESTS IN BOREHOLE***

**Test Procedure**:

* Conducted using a submersible electric pump with a capacity of 5 m³/h and a total head (HMT) of 80 meters.
* Tests must begin no later than 72 hours after borehole development.

**Flow Rate-Based Testing**:

* **Flow < 1 m³/h**: Single 4-hour test at ~0.7 m³/h, followed by a 1-hour water-level recovery measurement.
* **Flow 1–2 m³/h**: Two 2-hour stages at increasing flow rates (0.7–1 m³/h, then 1.5–2 m³/h), with a 1-hour recovery measurement.
* **Flow > 2 m³/h**: Three stages:
  1. 2 hours at 0.7–1 m³/h.
  2. 1 hour at 1.5–2 m³/h.
  3. 1 hour at ~70% of the maximum development flow rate, followed by a 1-hour recovery measurement.

**Short-Term Tests**:

* Conducted in three stages over 6 hours, with a 2-hour recovery observation. These begin only after the static water level is restored.

**Long-Term Continuous Tests**:

* Following short-term tests, a 24-hour continuous pumping test is conducted, followed by an 8-hour recovery observation.

**Conditions and Responsibilities**:

* No interruptions are allowed during pumping; if interruptions occur, the contractor must restart the test after restoring the static water level.
* Any irregularities must be documented in the site logbook and reported to the Project Manager's representative.

The pace of the measures will be the following:

|  |  |  |  |
| --- | --- | --- | --- |
| **1st​ LANDING** | **2nd​ LANDING** | **3rd​ LANDING** | **RISING** |
| Level static | 125 e minute | 190 e minute | 5th​ minute |
| 3rd​ minute | 130 e minute | 200 e minute | 10th​ minute |
| 5th​ minute | 140 e minute | 210 e minute | 20th​ minute |
| 10th​ minute | 150 e minute | 220 e minute | 30th​ minute |
| 15th​ minute | 160 e minute | 230 e minute | 40th​ minute |
| 20th​ minute | 180 e minute | 240 e minute | 50th​ minute |
| 30th​ minute |  |  | 60th​ minute |
| 40th​ minute |  |  |  |
| 60th​ minute |  |  |  |
| 80th​ minute |  |  |  |
| 100 e minute |  |  |  |
| 120 e minute |  |  |  |

**Measurement Tools**:

* Water speed will be measured using a water counter and calibrated bins of 50 and 100 liters.
* Water levels will be determined with an electric probe, and borehole depth will be checked before and after each test.

**Handling Sediment**:

* If sediment is detected at the borehole's bottom post-test, the contractor must perform blowing to clear it, per specified guidelines.

**Emergency Preparedness**:

* An emergency electric probe must be available on-site during the pumping test.

**Pumping Test Execution**:

* The contractor must maintain a consistent pumping flow rate and conduct all required measurements and analyses.

**Water Sampling**:

* Two 1-liter water samples will be collected, with details (village name, drilling number, time, date, and collector's name) recorded on the bottles.
* Samples will be hermetically sealed and transported to an approved laboratory at the contractor’s expense, following laboratory-prescribed storage and transport conditions.

The samples will be analyzed to determine the concentration of the settings:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Cations** |  | **Anions** |  | **Others settings** |
| Sodium | N / A | Chlorides | Cl | pH |
| Iron (total) | Fe | Sulfates | SO4 | Conductivity |
| Magnesium | Mg | Carbonates | CO3 | Temp. °C |
| Manganese | Mn | Phosphate | PO4 | Smell |
| Calcium | That | Fluorine | F | Taste |
| Potassium | K | Nitrates | NO3 | Color UCV |
|  |  | Bicarbonates | HCO3 |  |

 **Water Analysis**:

* Physicochemical and bacteriological parameters will be analyzed, including total and fecal coliforms.
* Results must be submitted to the project owner for approval before pump installation.

 **Site Protection**:

* Post-pumping test, sites must be secured with padlocked metal covers to prevent deterioration. The contractor is responsible for damages until submersible pumps are installed.

 **Drilling Head Installation**:

* Includes corrosion-resistant cast iron/steel tubes, reinforced concrete, protective hoods, flanged fittings, valves, anti-ram devices, and other accessories.
* A pumping test will verify functionality after installation.

 **Solar Submersible Pump Installation**:

* Pumps will be built to IEC or equivalent standards, handling 5m³/h at an average depth of 60m.
* Materials must be food-grade and corrosion-resistant.
* A Grundfos solar pump with a capacity of 40m³/day is specified, with detailed technical documentation required from the supplier.
* Pumps must be easy to maintain, capable of continuous operation, and matched to water quality requirements.

 **Photovoltaic System**:

* Polycrystalline/monocrystalline panels must meet environmental and technical standards, operating in high humidity and resisting winds up to 180 km/h.
* Panels will be mounted at a 12°-15° tilt, at least 1m above the ground, and secured with anti-theft measures.
* All structural components must be corrosion-resistant and galvanized.

 **Security Building**:

* A 9 m² caretaker’s building with robust construction will house technical equipment and provide power for lighting and mobile charging.
* The building will feature reinforced concrete, aluminum-zinc roofing, and integrated electrical systems powered by solar panels.

**1. Interior Coating**

* Interior walls to be coated with ordinary roughcast and finely troweled finishes.
* Layers include:
  + Render/bonding layer (500 kg cement dosage, 10 mm thickness).
  + Finishing layer (350 kg cement dosage, 5–8 mm thickness).
* Coating to include cement glaze for a durable and smooth finish.

**2. Exterior Coating**

* Exterior walls to be coated with Tyrolean plaster over the entire height, including vertical facings, edges, and scaffolding.
* Layers include:
  + Render/bonding layer (500 kg cement dosage, 10 mm thickness).
  + Finishing layer (350 kg cement dosage, 5 mm thickness).
* Exterior mortar coating to use site-sourced sand and a cement color approved by the project supervisor.

**3. Metallic Carpentry**

* **General Requirements**:
  + Supply and installation of frames, doors, shutters, grilles, hardware, and accessories.
  + All metallic carpentry to include anti-rust paint.
* **Doors**:
  + Entry doors to be manufactured with 15/10 sheet metal (2.20 m x 0.80 m dimensions).
* **Shutters**:
  + Adjustable louvered blades (12/10 thickness) with locking systems for enhanced security.

**4. Painting**

* Application of paint on all interior and exterior walls, metallic carpentry, and other metallic works:
  + Glycerophthalic paint for metallic surfaces.
  + Vinyl paint for internal walls and window supports (two layers).
* Protective coatings to ensure durability and aesthetic quality.

**5. Metal Water Tank (5m³)**

* Supply and install a 5m³ metal water tank raised 5 meters above ground.
* Features include:
  + Galvanized, stainless, or E24/1 steel construction with welded or bolted elements.
  + Food-grade internal coatings to ensure water safety.
  + Water level indicator readable from the ground.
  + Protective layers for corrosion resistance.
  + Proper sealing via waterproof liners or equivalent methods.

**6. Piping and Accessories**

* Galvanized steel pipes with welded or threaded connections.
* Tank equipped with:
  + Overflow and drain pipes for excess water management.
  + Ventilation chimney with anti-mosquito mesh.
  + Water level indicators and accessible manholes with ladders.
* Valves and fittings to meet operational durability standards.

**7. Welding, Sealing, and Surface Protection**

* Compliance with welding standards to ensure structural integrity and water tightness.
* All surfaces treated for corrosion resistance using approved methods (e.g., galvanization, epoxy coating).
* Bolted connections to utilize galvanized or stainless steel bolts with proper sealing.

**8. Connections**

* Use concentric or eccentric reducers as appropriate.
* Connecting parts such as tees, elbows, and valves to be galvanized and approved by the Design Engineer.
* Valves designed for ease of use and durability in open or closed positions.

**Watering Troughs and Lost Wells**

1. **Watering Troughs:**
   * Four troughs will be installed: three for large ruminants and one for small ruminants.
   * Dimensions:
     + Large ruminants: 8 m (L) × 1 m (W) × 0.6 m (H), partitioned with a PVC tube for overflow and sediment separation.
     + Small ruminants: 8 m (L) × 1 m (W) × 0.3 m (H).
   * Constructed with reinforced concrete dosed at 350 kg/m³.
   * Surrounding stone wall with sloped edges to enhance drainage and support.
2. **Lost Wells:**
   * Diameter: 1.5–2 m; depth: 2 m.
   * Features a rubble stone wall and reinforced concrete slabs for durability.
   * Equipped with a decantation area and a grid to filter debris and dirt.
3. **Evacuation Channels:**
   * Built for waterlogged areas with steep slopes to prevent erosion.
   * Designed with specific dimensions and slope adjustments based on terrain.

**Tank Ramp Connection**

* PVC pipes (50 mm, PN 10) will connect watering troughs to the reservoir at a minimum distance of 50 m.
* Proper sealing of pipe orifices to prevent contamination during interruptions.

**Protection Measures**

1. **Facilities:**
   * Earth grounding and lightning protection for all installations.
   * Galvanized steel wire mesh fences with a height of 2 m and gates secured with padlocks.
   * Interior ground covering with gravel or compacted lateritic fill.
2. **Water and Power Facilities:**
   * Borehole, solar panels, and technical rooms fenced with dimensions of 10 m × 10 m or 5 m × 5 m depending on structures.

**Water Distribution System**

1. **Pipes:**
   * Material: PVC, galvanized steel, or ductile iron, with dimensions and thickness based on the intended use.
   * Staking, trench excavation, and bedding layer preparation follow precise guidelines for soil types and load capacities.
2. **Pipeline Installation:**
   * Alignment must meet manufacturer specifications to avoid misalignment or damage.
   * Backfilling is allowed only after pressure tests and must use stone-free filler.
3. **General Testing and Disinfection:**
   * Water pressure tests are required for network integrity.
   * Pipes disinfected using calcium hypochlorite, ensuring residual chlorine levels meet safety standards.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **DN(mm)** | **Blanket minimal (cm)** | | | |
| **Steel** | **Ductile iron** | **PVC** | **PE** |
| 25- 50 | 80 | 80 | 80 | 80 |
| 50- 80 | 80 | 80 | 80 | 80 |
| 100 | 80 | 80 | 80 | 90 |
| 150 | 80 | 80 | 90 | 90 |
| 200 | 80 | 80 | 95 | 100 |
| 250 | 80 | 80 | 100 | - |
| 300 | 80 | 80 | 100 | - |
| 400 | 90 | 90 | 105 | - |
| 500 | 110 | 100 | - | - |
| 00 | 130 | 100 | - | - |
| 700 | 135 | 100 | - | - |
| 800 | 140 | 100 | - | - |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Depths rounded of there search (cm)** | | | | | | | | |
| **DN**  **(mm)** | **Steel** |  | **Font ductile** | | **PVC** |  | **PE** |  |
| **Min.** | **max.** | **min.** | **max.** | **Min.** | **max.** | **min.** | **max.** |
| 25- 50 | 90 | 130 | 90 | 130 | 90 | 130 | 90 | 130 |
| 80 | 90 | 130 | 90 | 130 | 90 | 130 | 90 | 130 |
| 100 | 90 | 130 | 90 | 130 | 90 | 130 | 100 | 140 |
| 150 | 100 | 140 | 100 | 140 | 105 | 145 | 110 | 150 |
| 200 | 100 | 140 | 100 | 140 | 115 | 155 | 120 | 10 |
| 250 | 110 | 150 | 105 | 145 | 130 | 170 | - | - |
| 300 | 110 | 150 | 110 | 150 | 130 | 170 | - | - |
| 400 | 140 | 180 | 130 | 170 | 150 | 190 | - | - |
| 500 | 10 | 200 | 155 | 195 | - | - | - | - |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Depths rounded of there search (cm)** | | | | | | | | |
| **DN**  **(mm)** | **Steel** |  | **Font ductile** | | **PVC** |  | **PE** |  |
| **Min.** | **max.** | **min.** | **max.** | **Min.** | **max.** | **min.** | **max.** |
| 00 | 190 | 230 | 15 | 205 | - | - | - | - |
| 700 | 205 | 245 | 175 | 215 | - | - | - | - |
| 800 | 220 | 20 | 185 | 225 | - | - | - | - |

The width of the excavations will be at minimum

1. L = D ext. + 0.40 m until DN 350
2. L = D ext. + 0.70 m has leave of DN 400

To allow a space free for the handling pipes

**Superstructure Works**

1. **Earthworks**
   * Includes general earth clearing, embankments, excavations, and well-digging as per the provided plans.
   * Additional excavation may be required for soft or weak soil, with costs borne by the contractor if over-excavation occurs due to negligence.
   * All excavations require approval from the delegated Project Owner before any backfilling or concrete pouring.
2. **Concrete Works**
   * Concrete must be mixed and placed promptly, within 30 minutes of adding water.
   * Compaction will use vibrators with specifications approved by the delegated authority. Over-vibration must be avoided.
   * Post-pouring, concrete must be watered for two weeks for curing.
3. **Repairs and Finishing**
   * Surface defects like honeycombs or fractures must be repaired only after inspection and approval.
   * Surfaces will be smoothened, and holes from shoring irons filled with cement mortar.
4. **Formwork**
   * Must be metal or wood, tightly sealed to prevent mortar leakage and designed for easy removal without damaging the concrete.
   * Stripping of formwork requires approval and should not occur before 12 hours post-concreting.
5. **Reinforcement**
   * Reinforced concrete will be used for essential structures, employing high-strength steel (HA Ø6).
   * Reinforcement must be stored and handled to prevent mixing of dimensions.
6. **Construction of Fence Wall**
   * Built with concrete blocks and masonry in English bond, with joints fully filled.
   * Retouching will ensure flawless delivery with clean surfaces.

**Materials for Execution**

1. **Equipment**
   * Probes, pumps, compressors, and geophysical tools must meet specified technical standards and site conditions.
   * Compliance with equipment quality and functionality will be inspected at project commencement.
2. **Material Standards**
   * All materials (cement, aggregates, water) must meet specified standards.
   * Cement should be fresh, stored under dry conditions, and free of lumps.
   * Aggregates must be clean, hard, and free of organic or earthy materials.
3. **Special Materials**
   * Tubing must comply with DIN standards and provide resistance to external pressures.
   * Gravel for filter beds must be clean, quartz-based, and stored properly.
   * Expansive clay for insulating dams must have specified swelling properties.

**Concrete Quality**

1. **Specifications for Concrete**
   * Minimum cement dosage per cubic meter depends on the type of construction (e.g., 250 kg for low-reinforcement concrete).
   * Compressive strength after 28 days ranges from 16 MN/m² to 25 MN/m², depending on the mix.
2. **Concrete Blocks**
   * Hollow concrete blocks must adhere to specified dimensions and quality standards.
   * Blocks will be cured under shaded conditions and watered for at least 10 days.
3. **Mortar**
   * Cement-sand mortar must be mixed thoroughly, achieving a firm yet flexible consistency.

**Composition of Concrete:**

* **Concrete Quality:** Aggregates must be homogenous, and concrete strength should rely on proper grading of aggregates rather than excessive cement. Materials must be weighed as per pre-approved proportions.
* **Water Dosage:** Measured precisely for consistency.

***Fitting of identification plate***

A plate identification should be stainless, resistant to shocks and to bad weather, will be anchored in the concrete, on a vertical face of the edge. The following information will be engraved on the plate:

*Village / nom du village Financement*

*Nom du Projet*

*Coordonnées GPS forage (UTM) W xx° xx . xxx’*

*N° séquentiel forage et code IRH Code xx*

*Année d’exécution:*

*Profondeur (m)*

*Crépines (m) de à NS (m) / Date*

*Date d'installation de la pompe*

*XXXXX*

*xxxxxxxx*

*N xx° xx . xxx’*

*xx*

*xxxx xx*

*xx xx*

*xx,x m - xx/xx/xxxx xx/xx/xxxx.*

The code IRH (Inventory of the Resources Hydraulics) and the number sequential, which will be assigned by the delegated Project Owner at the start of the works, uniquely identifies the village and the borehole.

**Restoration Measures**

1. **Quarry Conservation and Restoration:**
   * Quarries must be fully leveled before reforestation, based on an approved conservation program.
   * Nearby populations must be informed in advance about quarry operations.
2. **Regulatory Compliance:** Violations will lead to penalties per environmental protection regulations.
3. **Environmental Impact Mitigation:** Contractors must take steps to minimize negative effects, focusing on:
   * Protection of forest ecosystems, wildlife, and flora.
   * Preservation of aesthetic spaces.
   * Prevention of soil erosion, vegetation loss, disruption of hydraulic systems, and water pollution.
   * Avoidance of air pollution caused by construction activities.
   * Worker safety concerning occupational health risks during construction.
   * Restoration of material borrow sites post-use.
   * Addressing miscellaneous construction risks.
4. **Technical Protection Measures:** A final report detailing environmental protection measures must be submitted to the Project Owner upon work completion.
5. **Regulation Compliance:** Contractors must adhere to national environmental laws in Ghana and internationally recognized standards