
ANNEX A: STATEMENT OF WORK (SOW): RFP/HCR/KAD/SUP/2022/01

1. Background

Gebeish town is the capital of Gebeish locality and is home to 75,000 people. Over 6,500 are South Sudanese refugees. The entire population of 75,000 is served by 4 water supply systems (Two are owned by the Rural Water Corporation and the other two are privately owned). The 5th water source is a borehole that was drilled but never equipped thus locked and not accessible. The borehole is connected to the 2.2 km pipeline, 1,000m³ underground water tank, 2 elevated tanks @50m³, and 2 booster pumps @26 kW motor power, pumping unit installation was not done due to limited financial resources. The average water supply is 11 liters per person per day, however, with the presence of livestock within Gebeish and the surrounding rural villages, the supply needs to be increased to 25 liters on average per person per day. Generally, there are no household-level water connections across the entire town. Residents fetch water from public standpipes connected to the storage facilities and transported it by donkey cart/truck or they purchase water from water vendors from the nearest streets to their homes.

Refugees are settled in Dar Salaam areas on the outskirts of the Southern part of the town and approximately 1.8 km from the nearest public water supply system, fortunately, there is a privately owned water system about 700 meters from the refugee settlement.

UNHCR intended to upgrade and rehabilitate the existing water system this includes solarization of the system to improve its capacity and performance and increase coverage and access to safe drinking water for refugees, IDPs, and host communities.

2. General Information

1. Objectives, Purpose & Expected Results

The objective of the project is to upgrade and rehabilitate one existing water yard including solarization of the system in Gebeish town to increase the water coverage and improve access to safe drinking water for 75,000 people. The project will also contribute to strengthening social cohesion and promoting peaceful coexistence between refugees and the host communities.

2. Location and Description of the Assignment

All the projects will be in Gebeish town, West Kordofan, Sudan.

3. Scope of Work (Work Assignment)

The scope of work includes all activities related to achieving the outlined points below:

3.1 Provision and Installation of Submersible Pump:

- The contractor should provide and install a 2.5" Submersible Pump System PSk2-15 C-SJ17-18 or equivalent model for the borehole in strict compliance with the pumping test recommendations.
- The contractor/supplier shall install the submersible pump and related equipment following the instructions of the manufacturer, the technical drawings, and the specifications and installation standards in the design #1 general layout of the submersible pump equipment installation.
- Please refer to the attached general layout of pumping equipment installation for an electrical submersible pump.
- All materials and equipment should be checked and conform to the specified national or international standards. The general guidelines and instructions of the manufacturer on the installation of pumping equipment shall always be followed. Check that the voltage, phase, and frequency are compatible with the power supply availability. Check all cables: The motor cable and supply cable for damage that the cables are adequately sized to ensure the correct voltage at the motor. The low-level cable and connection must be tightened well with adhesive special material to avoid damage and the low-level unit has a good earth return through a steel borehole casing, earthed rising main, or separate earth return. The contractor under the direct supervision of the UNHCR assigned engineer will carry out insulation

- tests with a 500V insulation resistance and continuity tester (megger) on the motor and the supply cable. The resistance between any motor lead and the motor frame should be greater than 1 Mega-Ohm.
- The resistance between the individual cores of the supply cable should be greater than 1 Mega-Ohm. If a megger is not available, carry out a careful visual check on all cable insulation materials.
 - The Contractor should provide and install run-dry protection to trips off the pump before the water level reaches the pump intake and protect the pump from running dry and provide upper-level control to re-start the pump once the water level recovers to an appropriate level.
 - The contractor will install a tap at the discharge line to collect the water samples.
 - All the electric cables must comply with established standards. The electrical cables used for submersible pumps must be able to withstand underwater conditions inside the borehole for that specific water quality and the submerged cable joints should be of the encapsulated epoxy type or similar watertight standard.
 - During the installation of pumps and operations any direct introduction of oil, grease, fuel, etc. should be avoided into the borehole.
 - The equipment and assembly at the borehole head should be protected by a concrete structure of suitable design and size.
 - Two non-return valves must be fitted; one at the pump and the one at the surface where the rising mains joins the discharge line.
 - A flowmeter must be fitted immediately after the non-return valve. The manufacturer's instructions should be followed to assure accuracy and limit the turbulence at the metering point.
 - The meter must be calibrated and should be installed at least 1.2 m from any bend.
 - The flowmeter should be capable of measuring instantaneous discharge and cumulative volume with an accuracy of 5%.
 - A gate valve should be installed after the flow meter to control the discharge.
 - A running hour meter should be installed on the electrical control panel to keep a record of the number of hours the pump will run.
 - The contractor will ensure the make, model & serial number, type, motor capacity, and pump capacity should be marked on a steel plate and permanently installed at an appropriate place at the borehole head.
 - The contractor should install a pressure gauge to indicate any obstruction in the delivery line. Cover the top of the borehole to prevent the ingress of any contaminants.

3.2 Supply, Install, Test, and Commission of Distribution Pipeline from Existing Underground Water Storage Tank to the Proposed 50 m3 Elevated Water Storage Tank and from Tank to the tap stands:

- The contractor should supply, install, test, and commission 800m length of HDPE 110mm diameter from the existing underground water storage tank to the proposed 50 m3 elevated water storage tank, supply and install 1,400 m length, HDPE 90mm diameter from the elevated water storage tank to the proposed taps stand and women center.
- The scope of work includes bends, end caps, electrical connections, couplings, air release valves, gate valves, surface boxes or chambers with all needed accessories (flange adaptors, bolts, ladders, manhole covers, steps, etc) and all fittings, trial pits, excavation of, backfilling the work shall include the disconnection and reconnection of existing services to the new water supply system, typical details, specifications and as instructed by the engineer.
- Pressure testing, flushing, chlorination, and disinfection of the new pipelines before connecting them to the existing network as per technical specifications and engineer's instructions.
- Supply and installation of gate valve with a diameter of 100mm, PN16. Supply, cast, and install ready mix reinforced concrete (250 kg/sq. cm after 28 days) for the work of encasement of the water and drainage pipes (RCE), including formworks, bricks, reinforcing steel, excavation, reinstatement, transfer of surplus, etc. and all works necessary to complete the task.
- Supply and installation of all necessary materials, tools, fittings, parts and works to connect the existing pipes to the new or proposed pipes.

3.3 Construction and Installation of 50m³ Elevated Water Storage Tank:

- The supply of materials, the fabrications of different parts and elements of tank and tower, the handling of components, transporting, storing, construction of a foundation, erection of the tower, painting, and testing of leakages.
- The height of the tower shall be 6 meters to support 45 tonnes of water plus the own weight of the tank. Span shall be 2.3m both ways. The dimensions and specifications of the different sections are as follows: Main beams (architrave) shall be of IPE 200x100x22.4 kg/m or equivalent. Branch beams shall be of IPE 140x73x129 kg/m or equivalent. Stanchions shall be of two bays. Each bay is 3.5m high with a total height of 7.0m fabricated from a) HPB 120x120 kg/m or b) IPE 200x100x22 kg/m. All wind bracings shall be fabricated from 65x65x6 mm mild steel angles. Gusset Plates' thickness shall not be less than 6mm. Footplate and top plate thicknesses shall not be less than 16mm. Holding down bolts, nuts and washers shall be supplied complete with adequate sizes but not less than 16mm if 4 anchor bolts are decided to be used per footing.
- The contractor shall provide the shuttering and all necessary items required to undertake the foundation and concrete works, and erection of the tower and the tank up to satisfaction, and where the contractor is constructing the foundation blocks, he/she shall ensure that the blocks meet the dimensions and other requirements detailed on the installation drawings and any other instruction given by the supervisor. Prior to starting the erection of the towers and the tanks, the contractor shall ensure that the foundation blocks and the holding down bolts meet the dimensions detailed on the installation drawings and the instruction given by the supervisor.

3.4 Construction of Operators' Rooms:

- The room shall be 4m x 4m exterior dimensions and a clear headroom not less than 3.5m. The room will comprise two windows on the opposite sides as shown in the drawing. The room walling should be constructed with red bricks and mortar.
- Red bricks shall be class (1) as specified under brickwork and plastering paragraphs. Mortar shall be composed of one part cement and eight parts areas of sand.
- The foundation should be cleaned and wetted before bricks are laid, and all internal faces of brick walls shall be plastered.
- For roofing corrugated sheeting must be fixed with drive screws to purling through holes drilled on top of the corrugation. Drive screws shall be 300mm apart and bolts for fixing sheet together along the side corrugation shall be 450mm apart.
- Corrugated steel roofs shall be left clean and weather tight on completion and to the satisfaction of the engineer. Gang boards shall be used while fixing corrugated sheets to avoid cackling or bending of sheets.

3.5 Construction of Public Tap Stands:

- The public tap stand shall be constructed on-site, and it includes two side walls constructed out of first-class bricks of 25cm*12cm*7 cm dimension. A concrete slab must be cast on top of the side walls to form the platform for resting the water containers for filling from the taps as illustrated in the drawings. The wall's dimensions shall be in accordance with the technical drawings. The platform concrete shall be in accordance with concrete class B specification, reinforced by 10mm diameter bars. The contractor shall supply and fabricate the distribution pipe system to connect 10, 1" diameter taps as shown on the drawings and specifications named topical design of public standpipe.

3.6 Construction of Animal Troughs:

- The troughs shall be manufactured of mild steel sheets of 3mm thickness. The standardized trough capacity is 1 m³. The Construction Standards for the Animal Trough will be in accordance with the Technical Drawings, Bill of Quantities, and The General Specification and Construction Standards of Animal Trough
- The size of an animal trough is 3 m long, 0.9 m wide and 0.45m deep the trough should be manufactured from M.S. Plates 3 mm and the top frame M. S. Angles 1 ½ × 1 ½ × 4 mm and Gusset Plates M. S. Plates 3 mm. All welded from inside and outside and the edges of the cattle trough need to be folded.

3.7 Construction of Cart and Truck Filling Points:

- The filling points shall be constructed as per the technical drawings, Bill of Quantities, and Specifications attached.
- The construction of Standpipes for Cart and Truck Filling involves the Supply of materials (including gate-valve, connectors, reducers, elbows, tape, glue, pipes, connectors, elbows for drainage, etc.), transport and storage, labor, and all necessary equipment for 53 completed works.
- The construction works also include the drainage system as per Standard Drawing and as instructed by the Engineer on site.

3.8 Women, Mother, and Childhood Water Connection:

- The contractor will perform a water connection from the main water line to the women's center. The SOW includes the provision of 350 meters 2" UPVC pipeline, 2m³ horizontal plastic water storage tank, the height of the tower shall be 3 meters to support 2 tons of water plus own weight of the tank, the contractor shall provide the shuttering and all necessary items required to undertake the foundation and concrete works, erection of the tower and the tank up to the satisfying completion stages.
- The SOW shall include the provision of all required fittings, valves, reducers, outlet and inlet, caps, taps, and any other necessary material and equipment for the completion of the work

3.9 General Specifications for Civil Works:

- The general specifications and standards for the construction of civil works in the Water Yard should adhere to the following specifications:
- Concrete Standards should be in accordance with BS 5328.
- For reinforced concrete elements, use a mixing ratio of 1:2:4.
- For plain Concrete elements use a mixing ratio of 1:3:6.
- For masonry works use a typical mixing ratio of cement to sand as 1:6.
- Further specifications for civil works including aggregates, sand, water, bricks, reinforcement, concrete mixing, and curing should be in compliance with General Specifications and Standards for the construction of civil works in **section 8**.

3.10 Training of the pump operators on smooth operation and maintenance of the water system including switching on and off the installed solar system and troubleshooting minor technical defects.

4. Key Deliverables

- Provision and installation of 2.5" Submersible Pump equivalent PSk2-21 C-SJ17-26 in boreholes. The pump must work with solar or with Genset (hybrid).
- Provision and installation of solar power with a capacity of the 21,600-watt peak the solar panels with tilted angle 15 degrees support structure.
- Provide materials and construct the fence for the protection of solar panels and other components.
- Provision and installation of an earthing system and lightning arrester.
- Provision of materials, construction and installation, and connection of 50m³ elevated water storage tank, 6m tower high.
- Supply, install, test, and commission 800m HDPE 110mm diameter distribution pipeline from existing underground water storage tank to the proposed 50 m³ elevated water storage tank and 1,400 HDPE 90mm diameter of distribution line from the tank to the tap stands.
- Construction of 4mx4m exterior dimension and the clear headroom not less than 3.5m operator's room.
- Construction of 2 public tap stands and perform distribution line connection from the existing water storage tank tap stands.
- Manufacturing and installation of 4 animal troughs.
- Construction and connection of cart and Truck Filling Point.
- Perform water connection from the main water line to the women's center.
- Provision and installation of 60 KVA backup generator.

- The contractor shall submit samples of the materials used in the project UNHCR for approval before using them in the work.
- UNHCR may reject any material that does not comply with the described specifications in the BOQs and item 3 of this Statement of Work (Location and description of the assignment), in which case the contractor without any extra cost should replace the failed materials. UNHCR or the delegated Supervision Committee can ask for any test to ensure the quality of the material used and work. Only approved materials and workmanship should be used.
- UNHCR shall make any variation in the form of quality or quantity of the works that may in its opinion be necessary and for that purpose or if for any other reason, it shall have the power to order the contractor to review work upon mutual agreement. The contractor shall transport and, at his expense, all demolished rubbles and exceeded building materials to locations minimum distance of 2-3 km or as specified by the municipality and shall be responsible for cleaning out the site and it is surrounding areas at the end of usage.
- The contractor/supplier should provide a written warranty for supplied equipment and materials, the warranty should cover a period of at least two (2) years inclusive of labour, transportation, and expenses that are needed for the repair/replacement of defective equipment.
- Up on completion and before acceptance of the work the contractor/supplier shall furnish UNHCR with a written warranty stating that all works executed under the project are free from material defects and workmanship.

5. The Contractor Requisites

i. Experiences

The contractor shall have done a similar number of works or projects. The similarity should be within the size and the nature of the requested works in this SOW. The previous contractor's clients can be UN agencies, NGOs, governmental organizations, or large-scale private sector companies, and they should be able to provide a reference for the contractor.

ii. Minimum Staff

The contractor shall appoint a qualified project supervisor with at least five years of professional experience to work full time in supervising the implementation of work during the whole contract and warranty periods, and both the contractor and his engineer should work closely with the project supervisor for UNHCR.

The contractor shall appoint a qualified construction/water supply engineer with at least five years of professional experience in construction, upgrading/rehabilitation, and solarization of water yards.

iii. Minimum equipment

The bidder shall own or have access to all necessary number equipment needed to undertake the works. The availability of the required equipment should be checked before launching the operations.

6. Bill of Quantity (BOQ)

The specified job is all provisional, including the provision of materials and workmanship, providing water and electricity for the implementation and all other requirements to implement the job perfectly. The bidder must visit the site prior to submission of bid documents. The cost of this item should be included /embedded in the other items. Below is the BOQ:

item	Description	Unit	Quantity
1	Mobilization of equipment, personnel, and construction materials to the project site.	LS	1
2	Provision and installation of rising main made of GI Pipe 3m long	No	44
3	Installation of a piping system including delivery of 3-inch G.I. pipeline system between wellhead and water storage tank, distribution G.I. pipeline with 2 water meters, sluice valve up to the main existing distribution network	m	40

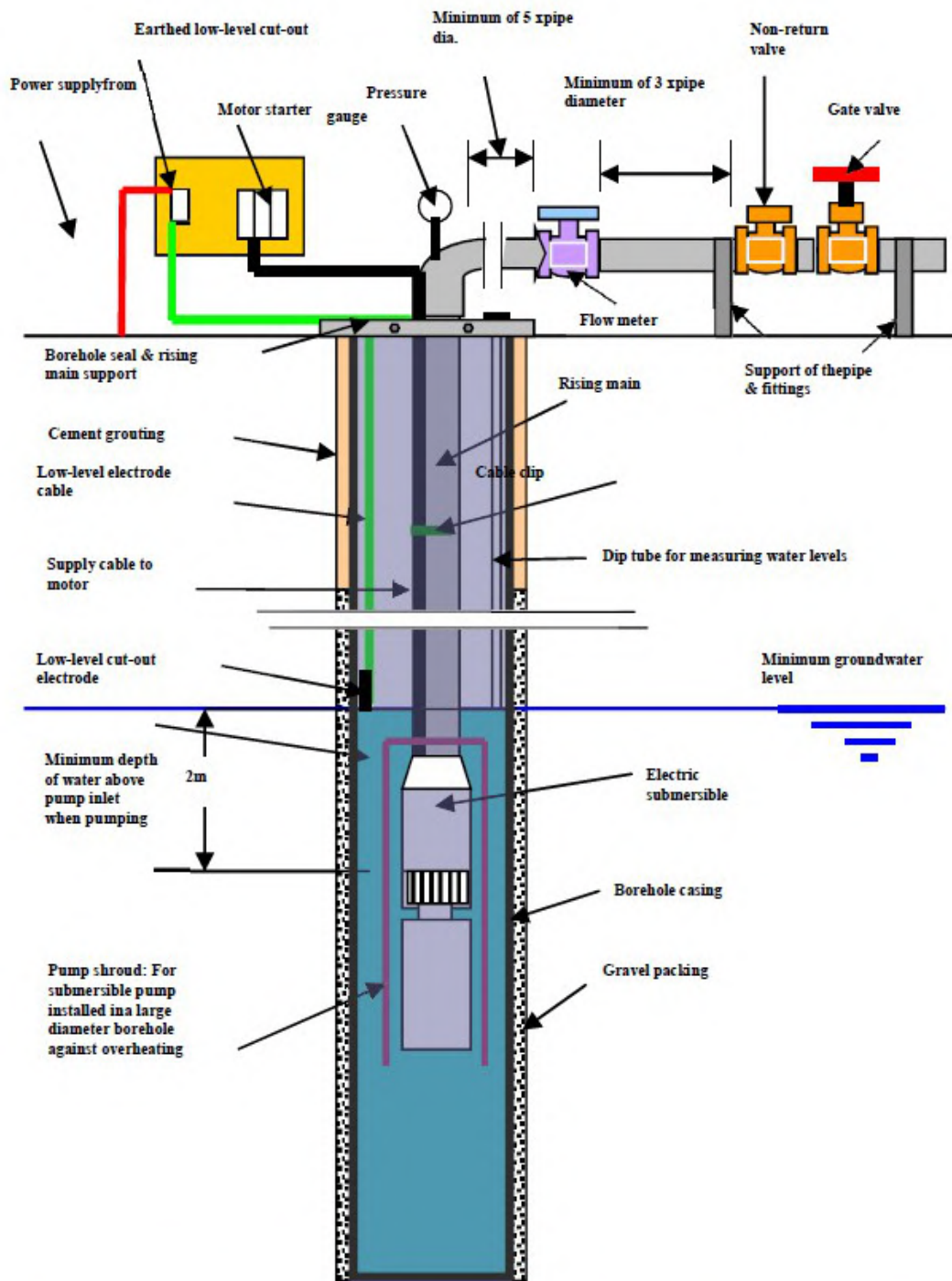
4	Provision of backup generator 60 KVA model with a prime power output of 60KVA, 48 kW and stand by the output of 66 KVA, 53kW at 0.8 power factor, 3 phase, 50 Hz at 1500 RPM, fuel capacity 180 liters, Dimensions (L/W/H) of 2300 x 1045 x 1551 or other equivalents to Perkins UK	NO	1
5	Construction and installation of 50 m ³ elevated steel water storage tank, Height of Tower shall be 6 meters to support 45 tons of water plus own weight of tank tower approximately, perform inlet and outlet with 2 control valve 3", complete with reinforced concrete foundation as dictated by soil conditions, outer and inner ladders, water leveling, final coating internal and external if required. To include wash-out and overflow G.I. pipes as per drawing and layout.	NO	1
6	Installation and delivery of HDPE pipeline system, 110mm diameter with 2 water meters, sluice control valve between the underground water storage tank up to 25 m ³ elevated water tank. Excavation in trenches for water line cost included in the unit cost.	m	800
7	Installation of distribution HDPE pipeline system, 90 mm diameter with 2 water meters, 3" sluice control valve from 25 m ³ elevated water tank up to the distribution points and the women's center. Excavation in trenches for water line cost included in the unit cost.	m	1400
8	Construction and fabrication of tap stand of 10 No 1" faucets. The tap stand shall be constructed on-site, and it includes two side walls constructed of bricks or sand cement blocks. A concrete slab is cast on top of the side walls to form the platform for resting the water containers for filling from the taps as illustrated in the drawings.	NO	2
9	Supply of local material, red brick, gravel, and sand and construction of plant operator's room as per drawing with 12mm, 1:6 mix plastering, 1:3:6 mix concrete floor, lime wash.	NO	1
11	Perform water connection from the main water line to the women's center the SOW includes the provision of 350 meters 2" UPVC pipeline, 2 m ³ horizontal plastic water storage tank, the height of tower shall be 3 meters to support 2 tonnes of water plus own weight of the tank.	NO	1
12	Provision and installation of 2.5" Submersible Pump equivalent to PSk2-21 C-SJ-17-26 in boreholes. The pump must work with solar and with Genset (hybrid). The pump system includes a controller (inverter) compatible with the proposed pump and solar panel configuration with data modules, motor, and housing to protect the controller from severe weather. The pump must be provided with full accessories such as protection from dry run overload, etc.	Pcs	1
13	Supply and installation of robust 360-watt peak monocrystalline 24 volts, 8.8 Amp, each solar panel must have one of these certificates such as ISO, CE RoHS, UL, IEC, and TUV. Module (solar panel) deployed must identification tag which should be able to withstand harsh environmental conditions and consist of the following information: * Name of the manufacturer of the Solar panels (PV modules) * Month and year of manufacture for each solar Panel. * Panel (Module) Wattage, I _{max} , V _{max} , FF, etc. * Unique serial number of the Panels (PV modules).	Pcs	60
14	Support structure to hold 60 Pcs of 360Watt peak- supply, fabricated, construction, and installation of the bolted support structure for modules, the support should be anchored to a concrete base, and the structure withstands wind speed (40 m/sec), the support structure should be from galvanized steel or heavy pipe and angles with	Set	1

	precoated anti-rust as base paint. The support structure is erect as a ground-mounted concrete base (40*40*50) cm. The tilted angle of the support structure is 15 angle degrees.		
15	Supply DC 16 mm cables (100 yards) single core one roll is red & one roll is black color the cables must be hosing with conduit or plastic (PVC) pipe for protection, cables shall meet the requirements of one of these certifications ISO, RoHS, IEC, and TUV.	Rolls	2
16	Supply AC Cables 16 mm- 4-core Supply must be hosing with conduit or plastic (PVC) pipe for protection (one rolls length 100 yards). Cables shall meet the requirements of one of these certifications ISO, RoHS, IEC, and TUV.	Rolls	2
17	Junction boxes (combiner Box) for Solar Panels with Dc Fuses- DC -Fuses (8); Pcs (25Amp 1000 Volt) with provided with cable glands, & conduit. The combiner box must be manufactured from fiberglass reinforced plastic (FRP)/ thermoplastic with IP65 protection, & shall be waterproof, and dustproof. The terminals should be connected to copper bus bar arrangement of proper sizes to connect cables from solar modules arrays & controller (inverter).	Pcs	1
18	Change over switch 200 Amp, 415 volts, 3- phase	Pcs	1
19	Lightning arrester and earthing system include star rod with cable 16 mm Single core with color green and yellow, 30 meters, equipotential busbar, earthing rods, set of joint cable, set of screws to the joint module via support structure.	Set	1
20	Install a fence with galvanized Iron poles 2-inch and 2 m high with concrete footing dimensions 30*30*40 cm with chain-link wire. The fencing should secure a distance of 3m for each direction (distance between fence & solar panels). To protect Solar panels from shading and theft.	Job	1
21	The cost of installation pump and electrical work	Job	1
22	Training of the 5 pump operators and guards for two days on smooth operation and maintenance of the water s supply system including switching on and off the installed solar system and troubleshooting minor technical defects.	Job	1

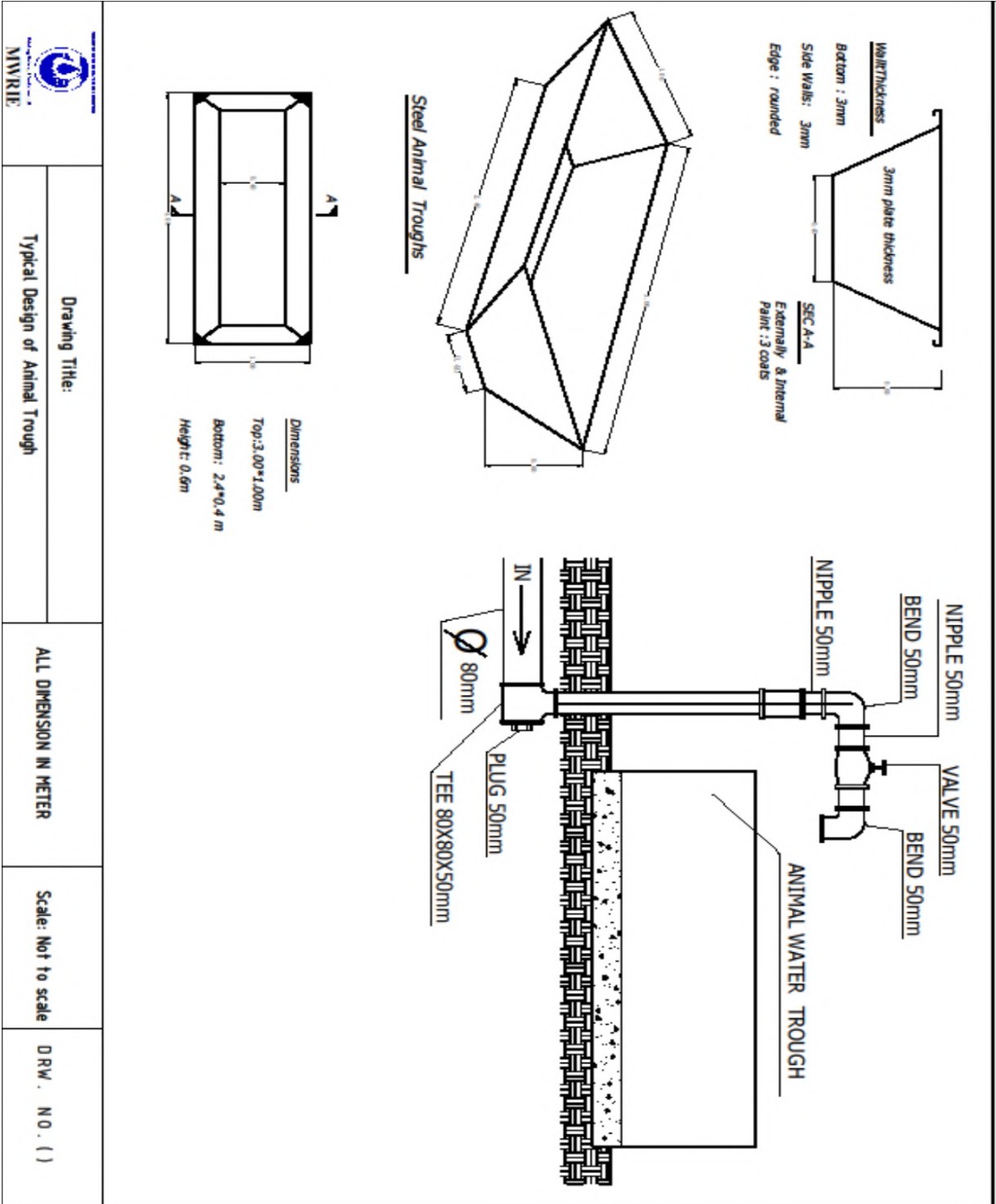
7. Site Drawings:

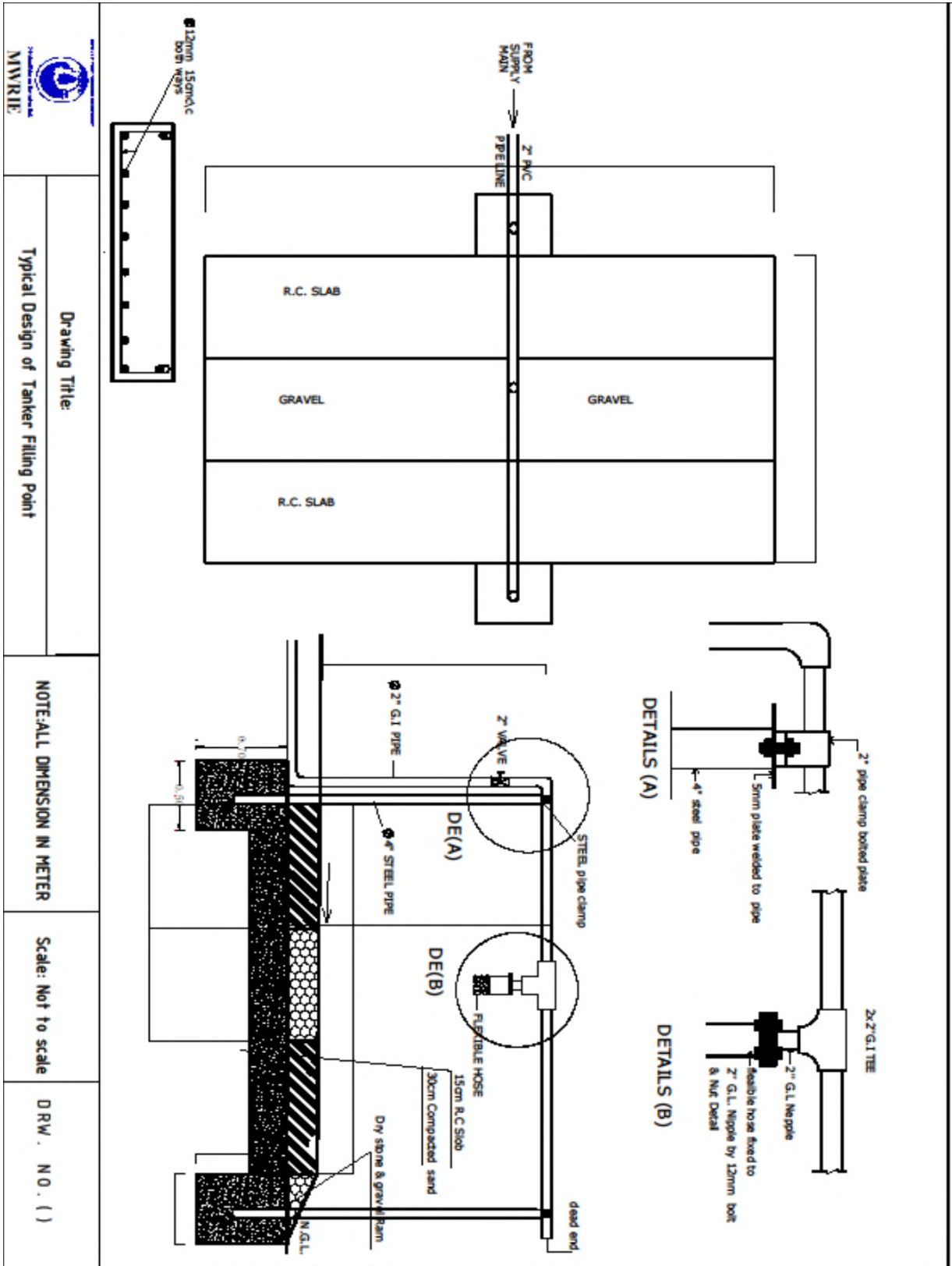
Below pages are the 10 sets of the site drawings:

1. Technical design of Electrical Submersible pump, Equipment, and installation 1
2. Technical design of the Generator room 2
3. Technical design of the Animals Trough 3
4. Technical design of the Tanker Filling Points 4
5. Technical design of the Public Stands Pipes 5
6. Technical design of the Inlet & Outlet Pipes Arrangements 6
7. Technical design of the 50m3 of Elevated Water Tank 7
8. Technical design of the Solar pumping layout 8
9. Women, mother, and childhood center water storage tank
10. Technical design of the General Water Station 9



General Layout of Electric Submersible Pump Equipment Installation



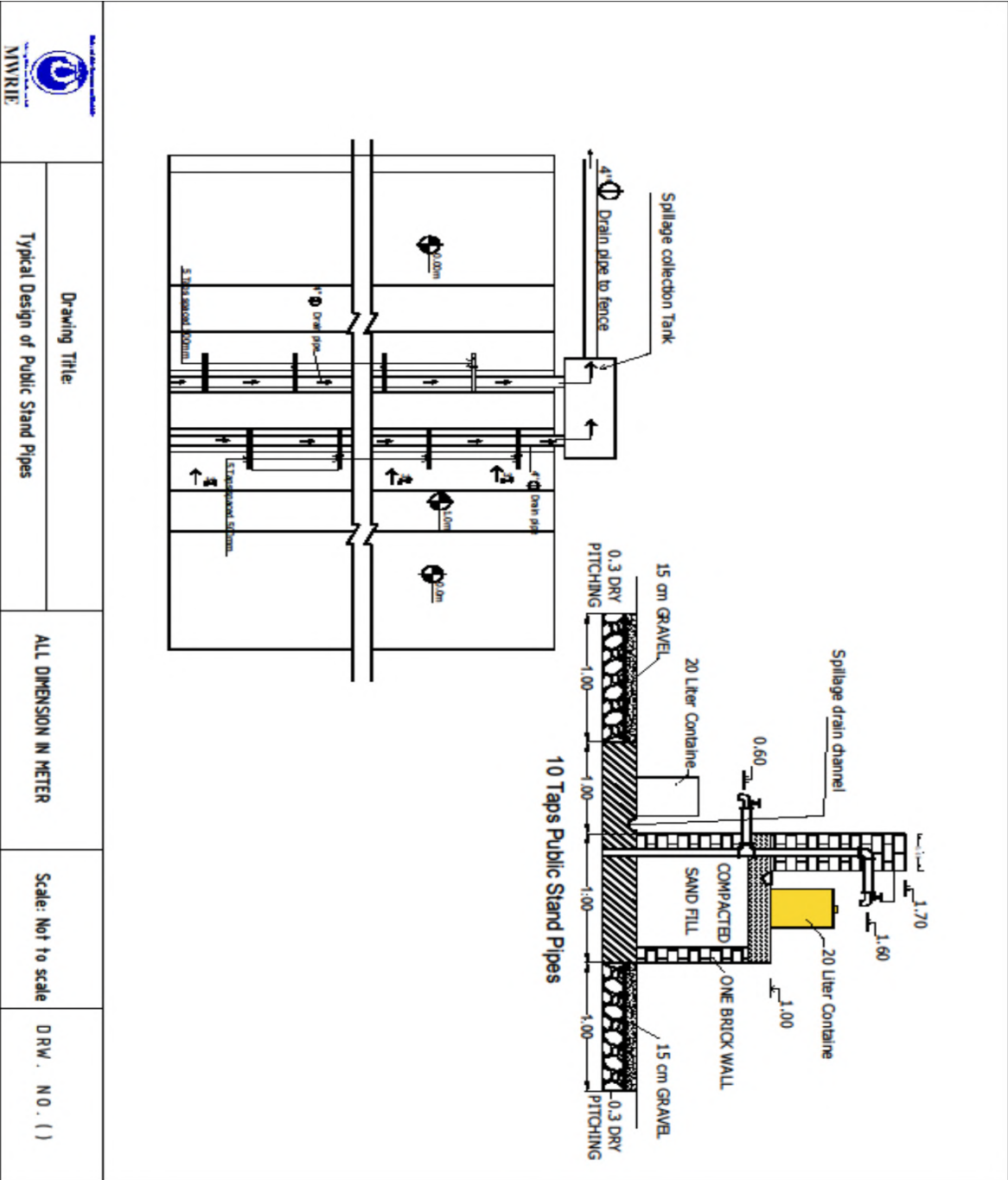


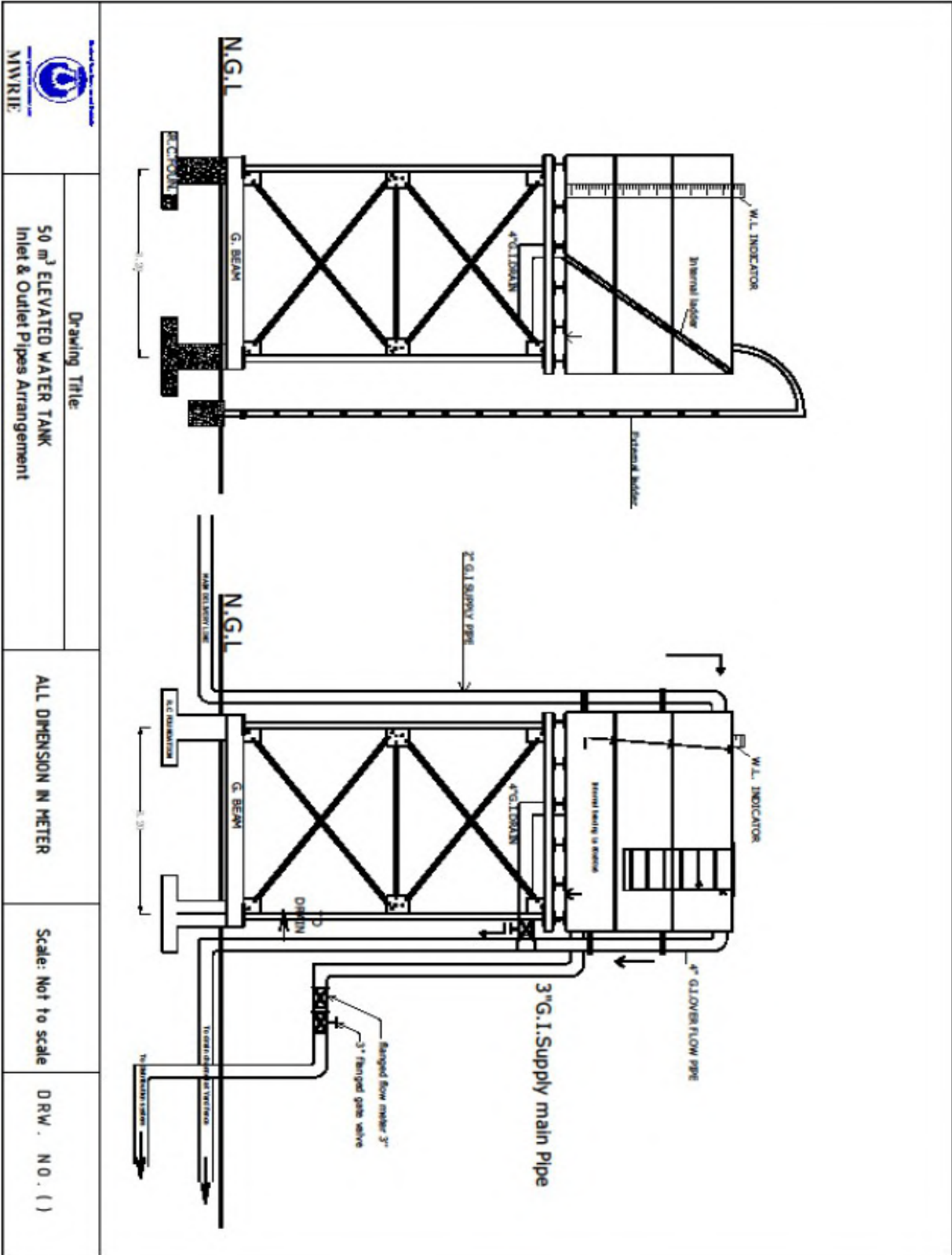
Drawing Title:
 Typical Design of Tanker Filling Point

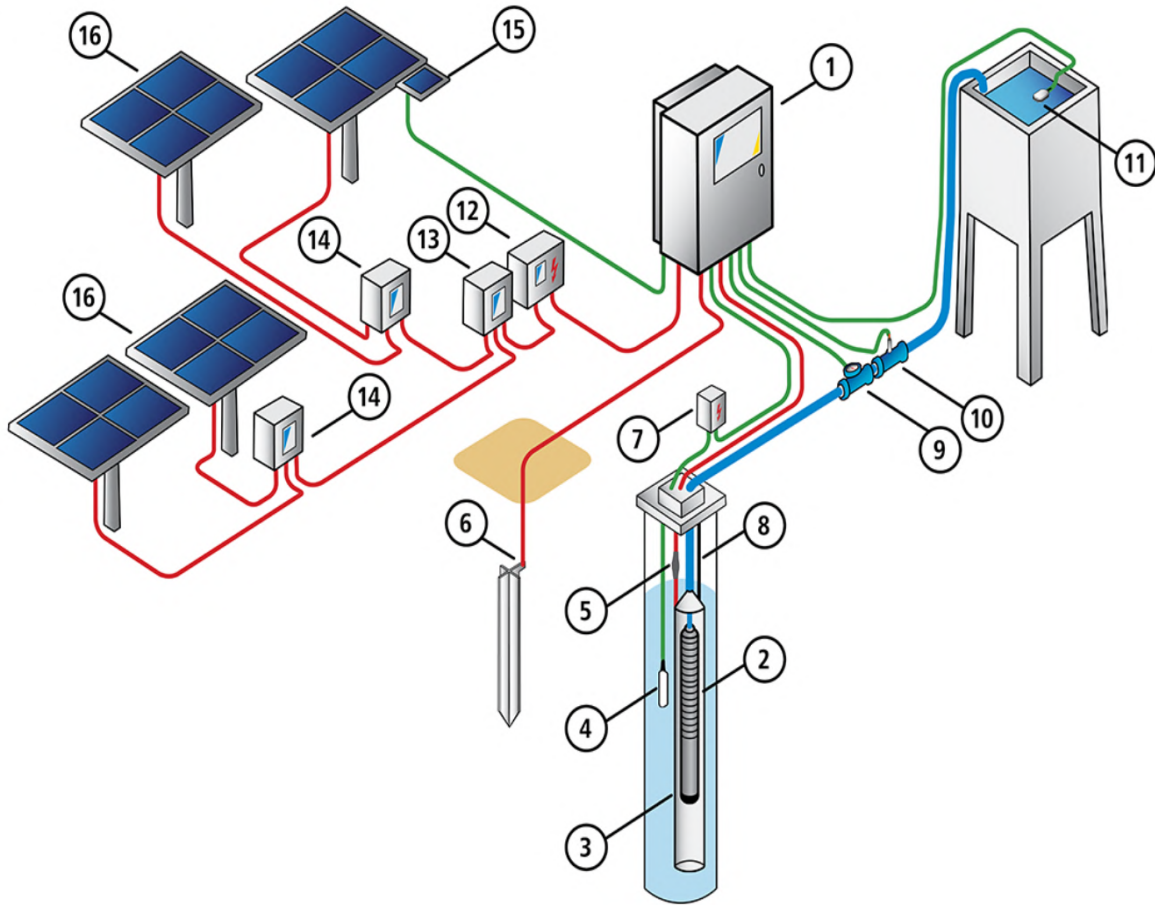
NOTE: ALL DIMENSION IN METER

Scale: Not to scale

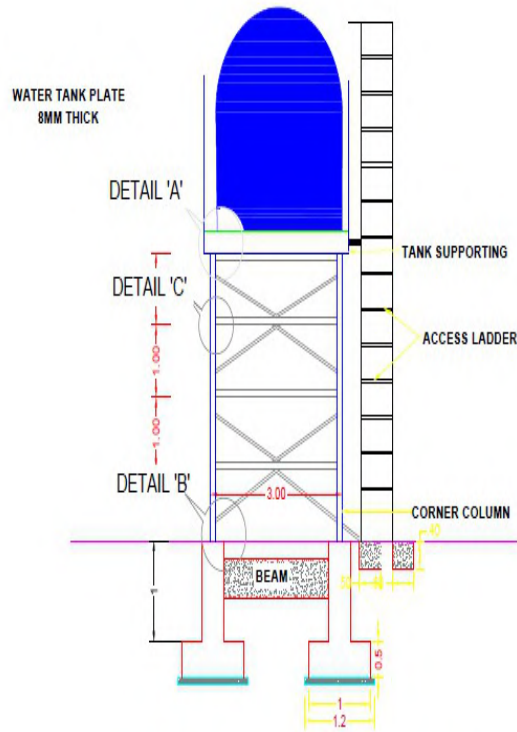
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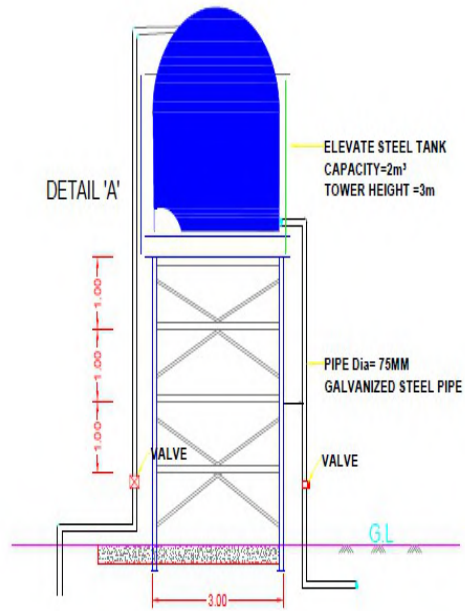




1. PSK2 Controller
2. Submersible Pump
3. Stilling Tube
4. Well Probe
5. Cable Splice kit
6. Ground Rod
7. Surge Protector
8. Safety Rope
9. Water meter
10. Pressure Sensor
11. Float Switch
12. PV Protect
13. PV Combiner
14. PV Disconnect
15. PV Module for Sun Switch
16. PV Generator

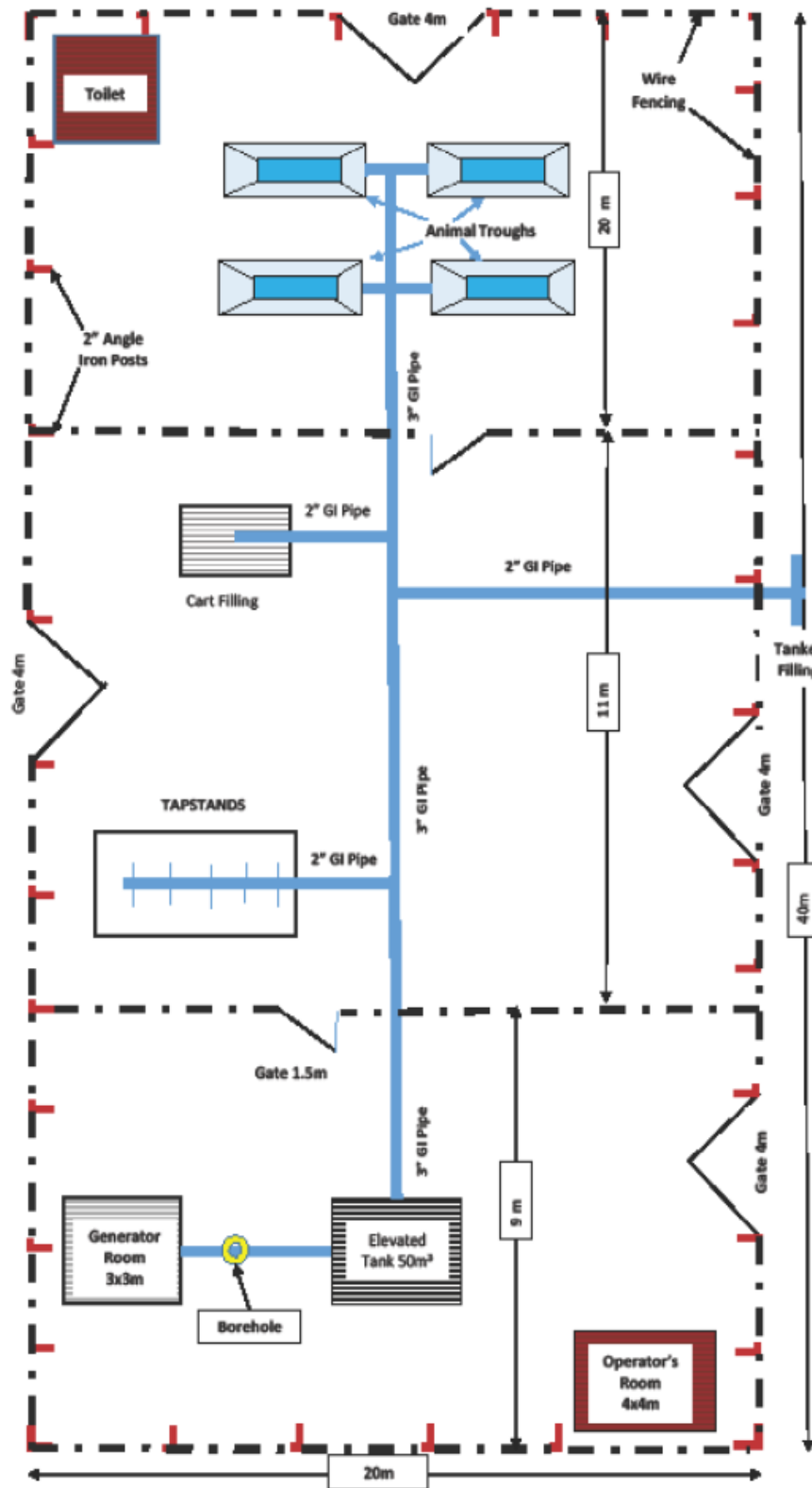


ELEVATION OF TOWER FOUNDATION



ELEVATION OF TOWER

The layout of water storage tank at women's center



8. General Specifications for Civil Works

1. SETTING OUT THE WORKS

The approximate lines, positions and levels are shown on the drawings. The contractor shall be responsible for accurate setting out of the works in relation to these lines, positions and levels and any reference data given to him/her by the engineer.

The checking of any setting out or staking of a line, position or level by the engineer shall not in any way relieve the contractor of his/her responsibility for the accuracy thereof.

2. SURFACE WORK

Clearing shall involve:

- a) The cutting of trees.
- b) The trimming of trees left standing
- c) The satisfactory removal and disposal of all cut timber, logs, shrubs, weeds, grass, herbaceous vegetation, and rubbish.

Removal of top soil shall be done as instructed by the engineer, disposed of and replaced with suitable material.

3. EXCAVATION WORKS FOR STRUCTURES

- a) Excavation for structures shall encompass the removal of all material within the boundary lines of the structure to the required depth and such additional excavation as required for ancillary works, such as drain channels and land grading.
- b) Foundations shall be excavated according to the boundary lines of the footings of the structure as shown on the drawings or as instructed by the Engineer.
- c) After excavation, the bed of the foundation of the structure shall be finished accurately according to the lines, positions and grades shown on the drawings, by thorough compaction and trimming using suitable tools and equipment.
- d) Any over excavation shall be backfilled with selected materials approved by the Engineer and thoroughly compacted by mechanical roller, tamper or by other approved method.

4. Concrete Works

The contractor shall supply all construction materials in quantities estimated to be sufficient for the work to be completed. The specifications of the material (water, cement, coarse aggregates, and sand) will be as follows:

Cement:	Unless otherwise specified the cement used in the works shall be ordinary Portland cement complying with British Standard BS 12.
Reinforcement:	Bars, Plain Reference R, to British Standard BS 4449. Deformed, Reference T to British Standard BS 4449; Fabric to BS 4443.
Sand	shall be clean, coarse-grained, with a maximum grain size of 5mm, contains no more than 5% silt, and shall be free of lime, clay, and any organic matter or other impurities.
Coarse aggregate:	shall be hard, clean and free from lime, clay and any organic substance, and shall be well graded between 6mm and 19mm in size.
Reinforcement	The reinforcing steel shall be free from oil, grease, dirt and paint. Any loose rust must be removed before use. All reinforcement bars shall be fixed and placed as indicated in the drawing.
Water	used for making and curing concrete shall be from a source approved by the engineer and shall be free from polluting matter which might affect the setting time, prevents the achievement of the specified cube strength, produces discoloration or promotes alkali reaction. The water shall be free from hydrocarbons and from suspended organic matter. Its inorganic suspended matter in solution shall not exceed 500 parts per million by weight and in suspension shall not exceed 30 parts per million by weight.

4.1. Storage of Materials

The contractors' arrangements for the storing and handling of materials for concrete shall be to the approval of the engineer. Such arrangements shall be directed towards preventing the direction, adulteration or segregation of the various materials and shall ensure ready identification and orderly use of cement.

4.2. Gauging Boxes

Gauging boxes shall be made and provided with pairs of carrying handles so that each box is carried by two men. The boxes shall be so proportioned that each mix is composed of a number of full boxes of aggregate and a full 50 kg bag of cement. Adjustment of the proportions of a mix shall be maintained in good order and shall be clearly marked with the mix for which they are to be used

4.3. Mixing Machines

All courses shall be machine mixed. Mixes shall be skipping loaded with skips that can be easily charged at ground level. Mixer shall supply water to the mix in a measured quantity. The mixer shall be of a size to mix concrete using only full bags of cement.

4.4. Classes of Concrete

The class of concrete to be used in each structure or part thereof shall be as detailed on the drawings or as instructed by the engineer. There shall be three classes of concrete used in the works:

Class	Nominal Max Aggregate Size mm	Compressive Strength N/mm 28 days		Slump (mm)
		Mean	Minimum	
A (1.1, ½, 3)	20	25	20	40-60
B (1, 2, 4)	20	22	18	25-50
C (1, 3, 6)	40	15	12	50-100

Unless otherwise detailed in the drawings, Class C concrete shall generally be used for blinding with plain concrete such as foundations to brick walls, floor slabs except generator houses, and thrust blocks. Class B concrete shall generally be used for beams and slabs, concreting valve chambers, floor slab generator houses and generator foundation, and foundations for storage tanks. Class A concrete shall be used for column and in water retaining structures.

The strengths quoted are for slumps in the range given. These slumps shall not be exceeded in concrete for the works but may, with the approval of the engineer, be reduced if compaction is satisfactory.

The coarse aggregate for class A and class B concrete shall all pass a 19 mm sieve, and none shall pass a 14 BS sieve and it shall be well shaped and well graded between these limits.

The coarse aggregate for class C concrete shall all pass a 38 mm sieve, and nothing shall pass a 14 BS sieve and it shall be well shaped and well graded between these limits.

The fine aggregate shall all pass a 5 mm sieve and shall be free from dust and well graded between these limits.

4.5. Mix Proportions

Concrete used in the work shall be a homogenous mixture of Portland cement, coarse sand, coarse aggregates and water.

The contractor shall prepare trial mixes in the same manner as for concrete for the works. The engineer may give approval for concrete from trial mixes to be used in the works, not necessarily

for their normal purpose.

The constituents of aggregates content for a 50 kg bag of cement shall be as follows:

Class	Coarse Aggregate	Fine Aggregate
A (1.1, ½, 3)	0.11 m ³	0.055 m ³
B (1, 2, 4)	0.14 m ³	0.07 m ³
C (1, 3, 6)	0.21 m ³	0.105 m ³
These quantities can be obtained using the following boxes:		
A 300 x 300 x 310 mm	4 boxes coarse	2 boxes fine
B 320 x 320 x 340 mm	4 boxes coarse	2 boxes fine
C 300 x 300 x 310 mm	6 boxes coarse	3 boxes fine

Only sufficient water shall be added during mixing of the constituents to form concrete having sufficient workability to enable it to be well consolidated to be worked into the corners of the formwork and around the reinforcement to give the specified surface finish and specified strength.

The water content of the mix shall be such that the slump is in the range given that, with the approval of the engineer slump maybe less than the minimum of the range if the compaction is satisfactory.

The contractor shall prepare test cubes from the trial; mixes using gauge boxes not larger than the maximum and for aggregate by reducing the level in the boxes. For the approved mixes the boxes shall be filled to flush.

4.6. Control of Mixing of Concrete

All concrete, including blinding, shall be thoroughly mixed in a concrete mixer. The water shall not be admitted to the drum of the mixer until all the cement, sand and aggregate constituting the batch are in the drum. Mixing shall continue until the concrete is uniform in color and for not less than two minutes after all materials and the water are in the drum. The entire contents of the drum shall be discharged before the materials for the next batch are put into the drum. No partly set or tempered concrete shall be used. Partly set or excessively wet concrete shall not be used in the works and shall be removed immediately its formed.

The contractor shall use weigh batching subject to the equipment being approved by the engineer.

If the engineer approves batching by volume then:

- a) Volumes of sand and aggregate shall be measured by gauge boxes specially made by the contractor and approved by the engineer.
- b) Gauge boxes shall be calibrated to match the use of cement in complete bags of known weight.

- c) No volume batch will be permitted which is based on part bags of cement, and
- d) Before making the gauge boxes, the contractor shall carry out tests to determine what allowance, if any, shall be made for bulking of the sand and any allowance shall require the approval of the engineer. Such tests shall be repeated as often as the engineer desires and the gauge boxes adjusted as required.

4.7. TRANSPORTING, PLACING AND COMPACTING OF CONCRETE

The contractor shall obtain the approval of the engineer to his/her proposed arrangements before starting concreting. No concrete shall be placed until the engineer has approved the reinforcement (section 5.14 to 5.17) and formwork (section 5.18 and 5.19).

Concrete shall be so handled that at the point of deposition it is of the specified quality and approved consistency, nothing having been added to it or lost from it since leaving the mixer.

Concreting shall be carried out continuously to the positions of joints prepared prior to starting.

The number and type of vibrators available for use during each period of concreting shall be as approved by the engineer. Approval will not be given if sufficient stand-by vibrators are not available in good working condition. The contractor shall regard the compaction of the concrete as a work of fundamental importance and shall produce a watertight concrete of maximum density compatible with the approved mix design. Compaction shall be assisted by use of mechanical vibrators available of the immersion type or by vibrating beam type vibrators. Any other method proposed by the contractor for the compaction of the concrete to the required density needs the prior approval of the engineer.

4.8. TESTING OF CONCRETE

The compressive strength of the concrete at twenty-eight days shall not be less than that specified in section 5.8, indicated on the drawings or as otherwise instructed by the engineer. The compressive strength shall be determined by crushing 150mm cubes of concrete, the cubes being made on the works and cured and tested as instructed.

Every batch of concrete shall be tested for slump at the place of deposit in the presence of the engineer. The contractor shall provide slump cones and compacting rods at every place of mixing and deposit. The maximum allowable slump shall be 125mm. The contractor shall allow in his rates for concreting for these tests.

4.9. CONCRETING IN UNFAVOURABLE WEATHER

The contractor shall not place concrete in permanent work during:

- a) During heavy rains or dust storms,
- b) When the air temperature is more than 43 °C.

When the air temperature exceeds 43 °C, the contractor shall not place concrete in the permanent work without the approval of the engineer and without taking such precautions as may be required to keep the temperature of the concrete during mixing and setting below 38 °C (e.g. keeping the concrete materials and formwork shaded from the sun, and the aggregate and formwork sprayed with water).

Concrete shall not be poured against formwork which is hotter than 30 degree celsius

4.10. BENDING SCHEDULE

The contractor shall ascertain for himself from the information given on the drawings and in the specification the quantity of steel reinforcement required.

4.11. BENDING OF REINFORCEMENT

Reinforcement bars shall be cut and bent when cold by machine or other approved methods to produce a gradual and even motion.

Dimensions of bent bars and internal dimensions of links and the like shall not exceed the dimensions given on the bar schedule or elsewhere. Unless described otherwise, bending dimensions shall conform to British Standard BS 4466.

Bars incorrectly bent shall be used only if the means used for straightening and re-bending do not injure the material. No reinforcement shall be bent when in position in the works without the approval of the engineer, whether or not it is partially embedded in hardened concrete.

4.12. TYING WIRE

Wire for tying and securing reinforcement shall be 1.6mm diameter annealed soft iron wire to British Standard BS 1052.

4.13. FIXING REINFORCEMENT

The contractor shall place and fix steel reinforcement accurately in the positions shown on the drawings and shall ensure that it remains rigidly in that position during the placing of concrete.

Supports, spacers and ties shall be approved by the engineer. Concrete spacers shall be made of the cement/sand mortar of proportion by volume 1:2 and mixed as given in section 6.2. Metallic spacers, fixing clips and tying wire shall be compatible with the reinforcement material and the specified cover should be maintained.

Unless otherwise shown on the drawings, nominal cover to all steel shall be 40mm.

Immediately before concreting, the reinforcement shall be examined by the engineer for accuracy of placement and cleanliness and corrected if necessary.

4.14. FORMWORK

Formwork shall be rigidly constructed of approved material and shall provide true to shape, dimensions and surface finish as detailed on the drawings or required by the engineer. It shall be fixed in perfect alignment and to the true shape and dimensions of the permanent work shown on the drawings. A method of support which would result in holes or tie wires extending the whole width from face of permanent work will not be permitted.

Except where otherwise specified, shuttering or concrete faces, which will remain hidden in the permanent work including faces which will be plastered, shall be (back) prevent the loss of any ingredients from the concrete and will produce a dense concrete surface.

Before each concrete operation, the formwork shall be examined to ensure that faces in contact with the concrete shall be free from adhering grout, projecting nails, splits or other defects which would affect the specified surface finish of the concrete. Joints in the formwork shall be

sufficiently tight so as to prevent leakage of cement grout and to avoid blemishes such as fins. Faulty joints shall be caulked.

No concreting shall commence until the engineer has inspected and approved the erected formwork.

The formwork shall not be struck until the concrete is sufficiently set to take all loads without damage. The formwork shall be removed by gradual easing without jarring. The contractor shall assess the period required between the placing of the concrete and the removal of the formwork and shall be entirely responsible for the consequences of removing the formwork.

In no case should the period be less than that is given below:

Sides of walls	36 hours
Sides of beams	48 hours
Short columns	48 hours
Long columns	5 days
Softies of beams and slabs	10 day

4.15. Construction joints

Where not shown in the drawings, the details and position of construction joints shall be submitted to the engineer for approval before any changes take place. They shall be located so that, in conjunction with the program for concreting, the effects of shrinkage and temperature are minimized. Where long lengths or large areas of work are to be concreted and where in the opinion of the engineer it is construction that concrete is four weeks old before new concrete is placed against it.

Construction joints shall be watertight. They shall be formed in straight lines with rigid shuttering perpendicular to the principal line of stress and as far as practicable at points of least shear. They shall be the plain butt type unless otherwise specified or approved.

Where water stops are required in construction joints they are shown in the drawings and the water-stop is detailed in the Bill of Quantities.

Before placing new concrete against that which has already been set the latter shall be treated carefully to expose the aggregate over the full section and to leave a sound irregular clean surface free from laitance.

Unless otherwise approved or specified, concrete placed in operation shall not exceed a vertical dimension of 3 m or a horizontal dimension of 7 m.

4.16. SURFACE FINISHES

Concrete surfaces of paved areas shall have a finish like that left by a vibrated hardwood board, 50mm thick, when used for screeding concrete to its proper level and profile immediately after deposition.

Exposed upper water retaining surfaces of concrete shall be floated with a steel trowel to a smooth finish. Other exposed upper surfaces shall be floated with a wooden trowel to a smooth finish. The floating shall be done so as not to bring excess laitance or fine material to the surface.

Except at movement joints, concrete surfaces which are to be covered by further concrete or cement mortar shall be thoroughly cleaned by hacking, wire brushing, washing with water or air under pressure, or other approved means in order to expose the surface of the aggregate and to remove excess laitance.

4.17. Curing of Concrete

The contractor shall until it has thoroughly hardened and for not less than 8 days or longer as specified by the engineer, protect the concrete from the harmful effects of rain, flood, wind, sun, high temperature, variation or reversal of temperature gradient, premature loading deflection or impact, and aggressive groundwater.

Unless otherwise approved by the engineer exposed concrete surface shall be kept continuously moist after casting for not less than 7 days. Such surfaces, immediately upon exposure, shall be covered with thick Hessian or sand or other material as may be approved by the engineer, which shall be in continuous contact with the concrete, and which shall be kept wet to the satisfaction of the engineer. A minimum thickness of 50 mm of sand shall be used for curing purposes and it shall not subsequently be used for concrete or mortar. If curing membranes are purposed by the contractor and approved by the engineer, they shall be applied in conformity with the manufacturer's instruction.

They shall be applied to unshuttered surfaces within 1 hour of concrete deposition at the surface.

5. BRICKWORK AND PLASTERING

5.1. SUPPLY OF MATERIALS

The contractor shall supply all construction materials in quantities estimated to be sufficient for the work to be completed. The specification of the material (Bricks, cement, sand, lime and water) is as follows:

5.2. Bricks

Bricks shall be obtained from one source approved by the engineer and shall be of the standard dimension of 225 x 75 mm the contractor shall supply to the engineer samples of ordinary red bricks and when approved these shall be the standards for bricks supplied for, the works and no bricks used for the works shall be lesser standard.

All bricks shall be new, clean, hard, sound and well burnt, equal in size, straight and sharp in the arises. The color shall be red, but uniformity of color is not essential.

Bricks delivered to the site shall be unloaded by hand and not tipped.

5.3. Cement, Water, Sand and Lime

Cement and water shall be in ratios specified for concrete work in section 5.3. Sand shall be to BS 1200. Lime putty shall be to BS 890.

5.4. MORTAR

Mortar shall be made of one-part ordinary Portland cement to six parts of sand by volume (cement shall be taken as 0.035 m³ per 50 kg bag). The mortar shall be machine mixed or, with the approval of the engineer, mixed by hand labor on a specially prepared mixing floor. Cement

mortar shall be protected from the sun and wind by a wet Hessian cloth and shall be used within one hour of mixing, after this time mortar shall be discarded and not used on the works.

5.5. Brickwork Workmanship

The concrete foundation or concrete floors shall be cleaned from earth, dust, debris etc. wetted before bricks are laid. Brickwork in solid walls shall be in Flemish or other approved bond and shall break joint correctly with the bricks in the previous course. Joint in brickwork shall be of uniform thickness and shall generally be not more than 10 mm in the beds and 10 mm at the ends, or such other dimensions as may be agreed by the engineer. The courses shall be laid level and with parallel neat and regular joints. Pretends shall be truly kept.

Immediately before being laid the bricks shall be thoroughly soaked in clean water and before continuing partly completed work the exposed bed joint shall be likewise soaked.

Brickwork shall be carried up evenly and uniformly, no one portion being raised more than 900 mm above another at any one time. No face work shall be built over hand.

Bed and vertical joints shall be filled solid with cement mortar as the brick are laid.

Unfinished brickwork shall be stepped back in courses and immediately before new work shall be thoroughly cleaned.

Bricks forming reveal and internal and external angles shall be selected with square edges and shall be built plumb.

Solid brickwork shall be fair faced on one side. Where 240 mm thick walls are ordered to be fair aced on both sides they shall be constructed solid in stretcher on bond with

British standard wall ties type (B) (or with 40 mm x 1.6 mm galvanized hoop iron ties

150 mm long or with butterfly ties of 4 mm mild steel bar) staggered at every six courses vertically and 800 mm horizontally.

The contractor shall protect and keep clean the face work.

The precautions to be observed in laying and protecting brickwork during hot weather and in curing finished work shall be as specified for concrete.

The contractor shall construct sample sections of wall so that the engineer may consider and approve the quality and appearance of the brickwork which the contractor proposes to employ in the work. The contractor shall, if necessary, build further samples wall until the quality and appearance required by the engineer is achieved. After approval the selected sample shall be retained as a sample to which all brickwork in the works must confirm.

Where brickwork beds on to or butts against concrete and there is no provision for a joint the concrete shall be brushed to expose the aggregate immediately the formwork is stripped

or when the concrete has just set or the surface shall be hacked back to ensure making a bond between the brickwork and the concrete.

5.6. COURSE HEIGHTS

General it shall be the average height of the bricks plus 10mm. The course shall be set out so that bed joints occur in line with sills, lintels and other features. Cut courses shall be avoided as far as possible. Course height shall not vary throughout the building and each course shall be level throughout the building.

5.7. BOND

The bond shall be Flemish bond (alternate headers and stretchers in each course) unless directed otherwise by the engineer. The Perpend shall be broken at one quarter of the brick length. Half brick walls shall be in stretcher bond with the Perpend broken at one half of the brick length.

5.8. POINTING

All external and internal brickwork, where left exposed, shall be finished to an even, true fair-face and pointed as details on the drawings or failing such detail with a recessed joint formed by specially shaped tool forced against the mortar in the joint.

5.9. KEY FOR PLASTER

Where brickwork is to be plastered, a key for the plaster shall be provided by raking out all vertical and horizontal joints in the brickwork to a depth of 15mm whilst the wall is being built.

5.10. WORKMANSHIP FOR PLASTERING

The plaster shall consist of cement mortar as specified in paragraph 6.2.

All surfaces to be plastered shall be cleaned and left free from grease, dirt, loose, or projecting mortar and should be well wetted before the work is done.

Internal and external plaster shall be 20mm thick, unless stated otherwise by the engineer, and shall be applied in a single coat.

The coat shall be thoroughly applied, straightened and brought to a true and even surface free from blemishes with a wood float. Corners shall be finished true, vertical, and even and constructed at the same time as adjacent wall surfaces.

5.11. SAMPLE PANEL

Before starting the brick work the contractor shall construct sample sections of wall until the quality and appearance of one receives the approval of the engineer. All subsequent brickwork shall be equal to or better than the approved sample.

5.12. FIXING OF WINDOWS AND DOORS

The contractor shall build into the wall, as is being constructed, the metal frames of windows and doors. Where the wall is not to be plastered the clearance shall be all round 3mm, where the wall is to be plastered the clearance shall be 10mm.

The work is to include building in approved metal lugs, making good, filling in completely with cement mortar the gap between the frame and the brick work, and raking out and pointing exposed edges.

6. ROOF WORKS

6.1. SUPPLY OF MATERIALS

The contractor shall supply all other materials necessary to complete the roofing works. The specification of the material is:

Roofing sheets- 26 gauge corrugated galvanized iron sheets

Roofing bolts-Hook bolts 9mm diameter complete with nuts and washers and angle iron

6.2. ROOF STRUCTURE

Comprises of angle iron trusses at approximately 1.5m centers with purling also of angle iron at 1.0m centers covered with roofing sheets.

6.3. FIXING OF ROOFING SHEETS

The sheeting shall be fixed with hooked bolts and nuts to the purling through holes drilled through the top of the sheeting corrugations. The bolts shall be at 350mm centers.

The bolts shall have a diamond shaped steel and plastic washer under the head. Gang boards shall be used to prevent cracking or bending sheets during fixing.

The sheeting shall be clean and weather tight on completion to the satisfaction of the engineer.

7. PAINTING

7.1. SUPPLY OF MATERIALS

Paint should be supplied in quantities estimated to be sufficient for the works to be completed. The specification of the materials is:

Paint, under coat Emulsion

Lime

The quantities of materials to be supplied are detailed in the bill of quantities and should the contractor consider the quantity of an item indicated in the Bill of Quantity is insufficient to complete the works, the contractor shall include in his/ her tender for the provision of the

additional quantity of the item.

The contractor shall supply all other materials necessary to complete the work.

7.2. WORKMANSHIP

The contractor shall regard the preparation of surfaces to be painted as work of fundamental importance. The object is to ensure the production of sound, clean and dry surfaces which shall have no detrimental effect on the material to be painted and the painting process.

Paints shall be thoroughly mixed under the supervision of a complete person in a manner approved by the engineer.

7.3. PREPARATION OF MAINTENANCE OF SURFACES

Rags, brushes and tools used in the preparation of surfaces contaminated with oil or grease shall be cleaned with white spirit. Immediately before paint is applied, the whole of the surface to be painted shall be thoroughly cleaned of all dust, loose paint or dirt by washing down with fresh clean water and brushing with a bristle brush as necessary.

Contact surfaces and surfaces to be painted shall be kept free of cement grout or concrete. Any such contamination shall be thoroughly washed away with fresh clean water before it has hardened.

7.4. PAINTING OF SOFT WOOD

Joinery which is to be painted shall be primed with one coat immediately after fabrication. Other softwood shall be primed before fixing. Contact surfaces with brickwork or concrete shall be given a second coat of primer.

After fixing and before applying any subsequent coats of paints cracks holes and blemishes in exposed surfaces shall be stopped with putty, and knots treated with an approved knotting. The priming shall then be made good with a further coat of primer.

The one undercoat and two gloss finishing coats of compatible oil-based paints from the same manufacturer shall be applied. On interior surfaces, the first gloss coat shall be rubbed down before the second (top) coat is applied.

7.5. PAINTING OF METAL

Unless otherwise specified, metal surfaces shall be cleaned by manual or mechanical processes. After cleaning, the surfaces shall be thoroughly rinsed with fresh clean water and allowed to dry. Final coat shall be applied as given in paragraph 67.

7.6. PAINTING OF CONCRETE, BRICKWORK AND PLASTER

The surfaces of concrete, brickwork, plaster and rendering which are specified for painting shall be prepared as given in paragraph 64.

Surface to be oil painted shall be:

Primed with one coat of approved sealer and painted with one undercoat and one gloss finishing coat of oil paint.

Surfaces to receive oil bound water paint:

Two coats of washable oil bound water paint. Comprising 50 liters of water, 45 kg of lime putty, 1 kg of powdered gum and not exceeding 1 kg of yellow ochre or other approved pigment.

Surfaces to receive lime white (Hawks solution) shall have:

An application in two cold coats of a solution formed by slaking freshly burned lime mixed with a suitable binder to prevent flaking.

7.7. CONDITIONS FOR PAINTING

During hot weather: Each coat of paint shall be allowed to dry and harden thoroughly before the application of the next coat. No painting shall be done in wet weather, dust storms or without the surfaces shall be shaded from the direct rays of the sun during the application and hardening of the paint.

Internal painting to buildings, other than priming and sealing, shall not be commenced until all trades have finished, and for plastered or rendered surfaces, until the surfaces have been fully hydrated and dried.

7.8. COLORS

Sample areas shall be prepared to determine color, finish and workmanship to a standard approved by the engineer. All work shall be to the same, or better, standard.

Bill of Quantities

PREAMBLE

- a) The Bill of Quantities forms part of the Contract Documents and is to be read together with the Conditions of Contract, the Specifications and the Drawings. The descriptions in the bill are only indicative and reference should be made to the Specifications and drawings for the full description of each item.
- b) The Bidder is to enter a price or rate against each item listed in the Bill of Quantities, whether quantities are stated or not. Items against which no price or rate is entered by the Bidder shall be deemed to be covered in other items.
- c) The prices and rates entered in this Bill of Quantities shall be full inclusive price or rate to construct, complete and maintain the work described in the Specifications and shown on the Drawings and shall include all costs (both incidental and contingent) which may be required for the construction and where required, the commissioning of the listed items together with all general risks, liabilities and obligations set out in the Bidding Documents on which the Bid is based.
- d) The quantities of work and materials listed in the Bill of Quantities are not to be considered as limiting or extending the amount of work to be done and material to be supplied. The Bidder must satisfy himself/ herself in respect of these quantities.
- e) The Bidder is advised that the prices and rates entered in the Bill of Quantities will be used if

an addition or deduction of the Works is made as a result of a Variation ordered by the Engineer, for the purpose of valuing the Variation.

- f) In the event of any arithmetical errors occurring in the extensions and/or totals in this Bill of Quantities, the extensions and/or totals shall be corrected in accordance with the Conditions of Contract by assuming that the quoted prices or rates are correct.
- g) Execution of work or the supply of goods, materials or services or for contingencies which sum may be used in whole or in part or not at all the direction and discretion of the Engineer.
- h) Interim payment for items priced as a Sum will be made based on the stage completion, with a fixed percentage of the total value of each work payable upon completion of each stage.
- i) All items are measured net or as described in the Specification. No allowance has been or will be made for waste.