

Engineering Technical Specifications

These technical specifications are an integral part of the contract documents, the terms of the contract, the drawings for the engineering works and the technical specifications related to all the civil, electrical, and mechanical listed in the Bill of Quantities (BOQ) attached to the contract. Samaritan's Purse hereinafter referred to as “Purchaser” and Contractor (Company) hereinafter referred to as “Service Provider”.

SECTION 1 – GENERAL

1. The field

- a. The scope of these specifications is to determine the material's quality, methods of quality control, methods of implementation, methods of determination of measurement, units, and the inclusiveness of prices.

2. Standards inclusiveness

- a. The specification items complement each other and each should be read in conjunction with the others.

3. Special specifications

- a. When any special specification is included in the contract items or the bill of quantities issued by the Purchaser, it shall be considered complementary to the general technical specifications. In the case of a conflict of special specifications (BOQ) with the general technical specifications, the special specifications shall be adopted.

4. Amendments

- a. The Purchaser only has the right to make or add any amendments to these specifications and the Purchaser made an agreement with the Service Provider on the financial obligations that result if there are any modifications.

5. Approved standard specifications

- a. All materials used in the fabrication, erection, painting, and structural steelwork shall be new or of first-grade quality without defects, cracks, grooves, or rough surfaces. They shall comply with the standard issued by the Central Iraqi Organization for Standardization and Quality Control (CSOQC) as the first priority, then the standards and constitutions issued by the International Organization for Standardization and Metrology (ISO), then the British Standards Institute (BS) and then the American Society for Testing and Materials (ASTM) and American Water Works Association (AWWA), and the American National Standards Institute (ANSI) followed by any internationally recognized and equivalent specifications mentioned. The Service Provider's responsibilities are to visit CSOQC, IOS, BS, ASTM, AWWA, and ANSI websites to get a copy of the most updated standards to carry out instructions and guidelines.

6. Approved units

- a. International System (SI) units and USA customary units are based only on the application of these specifications and on all the work and paragraphs specified in the Bill of Quantities.

7. Operational and implementing drawings

- a. The Service Provider shall study the engineering drawings and know all the structural, mechanical, and electrical details of the projects including drilling borehole, water distribution network, civil work, electrical and high voltage power connection. In case of proposing any amendment to the drawings or

specifications, the Service Provider must obtain approval from the Purchaser supervisor engineer before starting the implementation. The Service Provider is also committed to implementing all the general specifications according to measurements, dimensions, and paths in the attached drawings.

8. Materials samples

- a. The samples should be submitted before any activities of the work with detailed information provided by the Service Provider and after the approval of the Purchaser supervisor engineer on a form signed by both parties. The sample should be kept with the Purchaser engineer for cross checking.

9. Operation and maintenance manuals

- a. Provide at least 3 copies of the Operation and Maintenance manual, a complete parts list, recommended maintenance schedules and procedures, and a guide for the operation of all pumps, valves, and all electrical and mechanical items. The service provider will also provide any necessary training regarding operation and maintenance.

10. Measurements and payment

- a. The payment for this section will be based on the actual work carried out and in accordance with the unit prices shown in the bill of quantities. Only items mentioned clearly in the bill of quantities and implemented under this specification and approved by the supervising engineer will be measured and paid for. Any extra items used to complete the connections of the system or used in the electrical connections to get the water and electrical system operational per the approval of the supervisor engineer will be considered incidental to the project and will not be covered or paid for as separate items.

11. Modifications of specifications

- a. Modifications of these specifications may be agreed between the Service Provider and Purchaser's Supervisor Engineer to adapt to (Iraqi Standard Technical Specification) local conditions and procedures.

SECTION 2 – PREPARATION WORKS

1. Preserve the neighboring buildings and public services sectors

- a. The Service Provider is committed to preserving the neighboring buildings and other public services sectors during the implementation including, but not limited to roads, electrical power lines, water network, phone cables, schools, private buildings, and projects, etc. They are to implement project activities carefully to ensure the safety of the neighboring buildings to exempt him from any legal consequences. The Service Provider will be responsible to repair the damage that may occur in those buildings and return it to as it was before the damage and pay the necessary compensation costs to owners of neighboring property for the physical and moral damage caused by their work at the site.

2. Clearing the site

- a. The Service Provider shall maintain a clean work site and remove the scrap and unnecessary materials from time to time to keep all the site areas clean and to keep the roads open. The Service Provider will surround the site with the proper warning signs and safety indicators before the start of construction work.

3. Provide water and electricity

- a. The Service Provider shall provide the water and electricity services for the site during the working period according to the quantities and capacity required for the implementation of the project. The Service Provider is

responsible for the costs of delivering water and electricity and to pay the subsequent fees to be paid throughout the duration of the contract.

4. Temporary buildings

- a. The Service Provider should provide a site office and store (prefabricated cabin) of at least 30 m² area, with furniture including office room and toilet, with all electrical, plumbing, heating and ventilation, and all required accessories, to be used during the implementation period. Also, the Service Provider shall remove these facilities before the final handover.

5. Masonry works

- a. The blocks (solid) should always be used with dimensions (40, 20, 15) cm and must be carefully stored and kept clean and away from the ground, taking care when moving them on the site with easy access to workers. All masonry works are carried out according to the attached engineering drawings.
- b. The used block in the site must be of good quality and will be checked by the Purchaser supervisor engineer on the site.
- c. The sand should be clean and must not contain mud, according to the specifications, and should not be implemented before receiving the final acceptance from the Purchaser supervisor engineer.
- d. The used cement-sand mortar in the masonry works should be with a minimum of 300 kg cement/m³ of sand.
- e. The foundations must be kept clean of dust, mud, etc., and should be wet before block works.
- f. No section of the walls shall be constructed at a rate exceeding 1.5 meters per day without obtaining prior approval from the Purchaser supervisor engineer. Non-compliance with this requirement will result in the demolition and subsequent reconstruction of the work
- g. The cement-sand mortar layer applied above the surface of the wall must be uniformly leveled throughout the construction process. The thickness of the mortar layer must be consistent and not exceed 12 mm.
- h. All the corners and angles of the interior and exterior should be at 90° as much as possible and connected to each other properly. The construction work of the blocks should be vertical and fully balanced and at the intersection of two walls of the block. they should be connected to the building at the corner. The first inspection will be after the construction of the first row and in the final inspection construction Plumb-Bob Technique and meter will be used. In the case of the inclined wall, it will be demolished and built again.
- i. Cement shall be stored at the work site away from rain and moisture with high wooden pallets above the ground at least 25 cm from the walls.
- j. After construction, all walls must be cured with water at least three times per day, maintaining this process for a minimum duration of seven days to ensure proper wetting.
- k. Water used for cement-sand mortar shall be taken from the source of water used for drinking and should be clean and should not contain any dirty materials such as oils, acids, salts, and organic materials that may affect the construction.
- l. The balance tools will be used in the implementation work starting from the first row and up to the top.

6. The formworks

The formwork is used to form construction structures. The formwork is carried out with the following specifications:

- a. The wood must be clean and without any holes or cracks and it should be coated with greasy material to prevent adhesion with the concrete.
- b. The vertical stands shall be placed not more than 60 cm in both directions and horizontally with a distance not exceeding 50 cm, and the wooden supports shall be placed above them.
- c. The vertical stands are supported by two-way cross supports at the middle of the ceiling height to prevent bending and curving.
- d. The vertical metal stands are preferred.
- e. For ceiling wood: The height of the ceiling ends is determined by a fixed external point (using the level device).
- f. Metal strips are used to connect lintels and beam sides.
- g. For the wooden column, the construction Plumb-Bob Technique will be used to check the inclined column.
- h. Threads should be provided to fit the casting level to ensure the thickness and slope of the surface of the concrete.
- i. The formwork should be removed at least after 7 days of concrete casting.

7. Reinforcement works

The reinforcement bars will be supplied to the site at a length of 12 meters. The bars are bent according to the structural details shown in the attached engineering drawings. It shall be stored away from moisture and rainfall; otherwise, it must be well covered so that it does not rust. It must be as close as possible to the site so as not to impede the movement of workers or the transportation of materials. The following points must be taken into consideration when doing the reinforcement works:

- a. The reinforcement steel bar used should be from FF company (Erbil or Turkey), Mass company (Sulaymaniyah), or equivalent. Before using equivalent types, the service provider must obtain approval from the Purchaser's supervising engineers.
- b. The bars should be placed in their locations according to the attached engineering drawings, in order to ensure the necessary concrete cover to protect the reinforcement bars.
- c. The reinforcement bars should be supplied to the site with the lengths, diameters, and required force grades as per the attached engineering drawings. Do not replace any diameter with another, as what is available, without getting approval from the Purchaser supervisor Engineer.
- d. Reinforcement bars shall be checked after taking a sample from the work site in a laboratory at Mosul University and shall not be worked with until receiving the final test results and conforming to the engineering specifications.
- e. The reinforcement bars shall be cleaned from rust, grease, and oils using steel brushes, sand guns, or any other suitable method approved by the Purchaser supervisor Engineer before cutting, forming, and installation.
- f. Cold bending works should be used without any flame or heat.
- g. Avoid using any bars after bending them for other works.
- h. Reinforcement bars should be connected using steel wires not less than 1.5mm in diameter using the plier.
- i. Plastic or concrete spacers should be used to ensure the cover for the reinforcement bars and the distance between spacers should be at least 80cm.
- j. Dowels that stand above the concrete level shall be protected from rusting and damaging. Low cohesive concrete can be used to ensure easy breakage when needed in the case of vertical extension.

8. Concrete works

The concrete should be mixed on site or supplied from companies out of the area that not exceed 45 minutes of transportation time. It is strongly preferred that the concrete is mixed on site.

The following points should be considered during the work:

- a. Clean the formwork before casting and make sure it is free from any dirt.
- b. *Compressive strength test*: concrete C25 will be used with a mixing ratio of 1:1.5:3, Laboratory samples will be taken by using cubes (15x15) cm and 6 samples per 50 cubic meters or during each time casting concrete. In the case of failure of the laboratory test, it should go to the Core Test at the Service Provider's expense and at the Purchaser's request.
- c. The cement type used should be Mass sulphate resistance cement for the foundation and Ordinary Portland cement for lintels and slab.
- d. The casting concrete shall be distributed evenly and uniformly on the entire surface of the formwork.
- e. A mechanical or electrical vibrator must be used during casting, and no concrete parts should be left without using the vibrator. The vibrator shall be used in one place for 5-15 seconds depending on the concrete mixture and water-cement ratio. Under no circumstances should a vibrator be used for more than 15 seconds to avoid the separation of concrete compounds (segregation). Generally, the vibrator should be used by an expert in such a device.
- f. The surface of the concrete should be adjusted with the available equipment as soon as the casting is finished. If a part has been cast, it should not be moved or touched.
- g. The concrete shall be completely free of voids, uncovered bars, poorly filled, or other disadvantages.
- h. To avoid segregation, the height of the concrete dropping should not exceed 70 cm, and all parts must be cast at the same time.
- i. It is never allowed to use additional water for concrete during casting.
- j. Concrete shall be protected for 7 days after casting from harmful effects, shocks, and vibrations until it hardens sufficiently.
- k. The Service Provider shall keep accurate and updated records showing the dates and times of casting concrete and shall be inspected by the Purchaser supervisor Engineer at any time. The Service Provider shall also record the results of the concrete test from the laboratory at Mosul University.
- l. Concrete should cure with water for at least 7 days after casting, using sand breakers filled with water. For concrete columns, canvas or blankets should be used for curing.
- m. Service provider not permitted to cast concrete in cold weather (temperatures below 5°C) or very hot weather (temperatures above 35°C). These restrictions will not result in an extension of the project duration.

9. Cement plastering works

- a. The sand should be clean and without any clay materials.
- b. All walls should be cleaned before plastering to get rid of clay materials and dust.
- c. A water jet will be used before starting plastering.
- d. Cement plastering with 20mm thickness smooth-finished for exterior, interior walls, and ceiling. Plastering will consist of three layers as follows: the first layer of cement splash dash, the second layer of rough should have fine gravel (kafmal) including putting a layer of metal mesh between block works and

- concrete works (columns, beams, and lintel) and on electrical P.V.C pipes, and the third layer smooth finished cement plastering with cement-sand mortar.
- e. Avoid any curvatures or irregularities as all wall angles should be right angle 90 degrees.
 - f. If more than 2.5 cm thickness is needed, a metal mesh should be used during the first layer work.
 - g. Curing concrete should occur three times per day for 7 days.
 - h. Vertical rulers will be utilized, ensuring that no gap greater than 5 mm exists between the rulers and the wall along the entire height of the wall.
 - i. All the rulers of one wall must be straight and vertical.
 - j. All electrical works should remain safe during work.
 - k. Ruler will be used at the final inspection.

10. Electrical works

- a. Ensure the safety of all wires by testing with an electrical Avometer.
- b. Ensure that all the diameters, sizes, and types of wires are used as per the BOQ and attached engineering drawings.
- c. All plugs and switches should be 120 cm height from the finish floor level (F.F.L) of the interior walls and 150 cm above the level of the floors for exterior walls.
- d. Plastic electrical pipes size 25-40 mm should be used on the walls and slabs and fixed by plastic clips. The distance between clips shall not exceed 1 meter.
- e. The switches box should be fixed on the same level otherwise it will need to be reworked.

SECTION 3 – LABORATORY TESTS AND SITE VISITS

The Service Provider should commit to do the following laboratory and site tests. The costs of the laboratory tests will be paid by the Service Provider and the duration of laboratory tests will be within the contract period. All the laboratory tests must be conducted at Mosul University laboratories.

1. Laboratory tests

- a. Concrete Compressive Strength Test
 - i. The test will be according to the British code (BS EN 12390-3) to determine the ability of the concrete to hold the pressure forces applied to it.
 - ii. Testing method: The samples are taken from the fresh mixing concrete at the site. 6 cubes with (15x15x15) cm dimensions are filled on three layers. Compact each layer with 35 strokes per layer using a tamping rod (steel bar 16mm diameter and 60cm long, bullet-pointed at the lower end). After finishing compacting the top layer, leveled with the surface of the cube by the ruler, the necessary data is written on the concrete cube on the upper face the date of casting, and the concrete type. The filled cubes are kept away from sunlight and any vibration for 24 hours. After that, the cubes will be put inside water and then tested.
- b. Steel Tensile Strength Test
 - i. The tensile strength test will be according to the British code (BS EN 10002-1), applying a high load on the sample according to certain standard specifications by holding both ends with special equipment and placing the axial load on it, so the bar length will increase.

2. Site tests

- a. Slump test
 - i. The slump test will be applied on the concrete mix before casting in the site to determine the workability of the concrete, the concrete strength, and the

percentage of water to be added before casting. A cone is used with a height of 30 cm, a bottom diameter of 20 cm, and a top diameter of 10 cm. The concrete will be placed in the cone on 3 layers, Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross-section of the cement mixture. The tamping rod is of steel 16 mm diameter and 60cm long and rounded at one end. After finishing the compaction, the surface is leveled and then the cone is lifted vertically to the top slowly and carefully. The cone is placed vertically next to the concrete moisture which was inside it. The compacting bar is placed on the top base of the cone horizontally towards the concrete moisture. The distance between the bar level and the highest point level will be the value of the slump test.

- b. Electrical check
 - i. The electrical wiring system should be checked after work completion by Avometer. The main external cables and internal will also be checked.
- c. Borehole Tests and Cleaning
 - i. The service provider will be responsible to provide equipment and other requirements to perform the washing and cleaning of the borehole by using an air compressor with pressure not less than 15 bars until the water gets clear, and achieving a hydraulic test of (S.D.T.) standard drawdown test. The test must comprise all necessary information about the static and dynamic water level, borehole loss, borehole efficiency, and effective borehole radius. Pump tests must be conducted for a minimum of 12 hours. All works should be implemented according to the instructions and supervision of the geologist committee and the site supervisor. Then deliver the water samples to The General Director of Nineveh Water Department laboratory for physical, chemical, and biological tests to identify the parameters of the water. The Service Provider will be responsible for the cost of testing and re-testing if necessary.

SECTION 4 – SAMPLES

The Service Provider must provide at least three samples of the material proposed for use for the Purchaser's approval. This includes the required technical data, test certificates, certificates of origin, etc. This includes but is not limited to pipes, steel, valves, electrical and solar elements, cables, construction materials, paint, doors and windows, etc. The samples must be approved by the Purchaser's Engineer before transportation to the site.

SECTION 5 – HDPE PIPE NETWORK

General

This section includes material and installation requirements necessary for furnishing and installation of High-density polyethylene (HDPE) pipes, fittings, and specials in the locations and quantities as shown on the drawings.

1. Quality criteria

- a. Reference to industry standards as contained herein shall be constructed as to be in reference to the latest revision or edition.
- b. The pipe fittings and specials shall be made by a manufacturer experienced in producing pipe, fittings, and specials of the type, size, configuration, and quality specified herein. The manufacturer shall have produced pipe, fittings, and specials with at least ten years of successful performance.

2. Submittals

- a. Before implementation, the Service Provider shall submit shop drawings showing the pipe lengths, design details, joint details, specials, etc., for the Purchaser's Engineer approval. All works shall be fabricated in accordance with these plans.
- b. The Service Provider shall submit a notarized statement of certification from the pipe manufacturer as to conformance with the specified ANSI/AWWA specifications listed herein, and modifications thereto, at the time of submitting shop drawing data on the pipe and fittings.

3. Delivery, storage, and handling:

- a. The Service Provider shall be responsible for the acceptability of all material furnished and shall assume responsibility for the replacement of all such material found damaged in shipping or defective in manufacture. This shall include the furnishing of all material and labor required for the replacement of installed material discovered to be defective prior to the final acceptance of the work.
- b. The interior as well as all sealing surfaces of all pipe, fittings, and other accessories shall be kept free from dirt and foreign matter. Consult the manufacturer for specific storage recommendations.
- c. Materials shall be handled properly at all times to prevent damage in accordance with the manufacturer's recommendations. Pipe and fittings shall not be thrown, dropped, or dragged.

Products

1. HDPE pipe

- a. Where required by the Purchaser, the Service Provider must provide for approval at least three samples of the material proposed for use, along with the required technical data, test certificates, certificates of origin, etc. The samples must be approved by the Purchaser's engineer before transporting and implementation on the site.
- b. Polyethylene pipe shall be manufactured in accordance with ASTM F714. The diameters shall be as shown on the drawings.
- c. The polyethylene pipe shall be rated for use with water at 73.4° F (23° C). at hydrostatic design stress of 800 psi and a minimum working pressure of 160 psi.
- d. Polyethylene extrusion compound from which the polyethylene pipe is extruded shall comply with application requirements for PE-3408 high molecular weight polyethylene plastic material. Material shall be as described in ASTM D1248 and shall comply with the following:
 - i. Pipe resin shall have a minimum inherent viscosity of 2.5 when run according to ASTM D1601.
 - ii. Have a specific gravity of between 0.9141 and 0.955.
 - iii. Contain a minimum of 2% and a maximum of 3% carbon black and shall produce a uniformly black finish product.
 - iv. Marking on the pipe shall include a **blue stripe for the water transmission main**; the nominal pipe or tubing size; the type of plastic material, i.e., PE-3408; the standard thermoplastic pipe dimension ratio or the pressure rating in psi for water at 73.4°F. (160 psi); the ASTM designation with which the pipe complies; and the manufacturer's name or trademark and code.

2. Fittings and Joints

- a. Fittings shall be fabricated to the same standards as the pipe from the same raw materials by thermal fusion. Jointing shall be by the thermal butt-welding method

as recommended by the manufacturer. Fittings and joints shall have a pressure rating equal to the pipe and shall have machined fusion ends matched to pipe wall.

Implementation

1. General requirements

- a. Openings such as stubs, tees, and other services along the lines shall be securely closed by means of an approved stopper that fits into the pipe and is recommended by the pipe manufacturer. This stopper shall be jointed in such a manner that it may be removed at some future time without injury to the pipe itself. At the close of each day's work and other times when the pipe is not being laid, the end of the pipe shall be temporarily closed with a close-fitting stopper.
- b. All necessary precautions shall be taken to prevent the entrance of mud, sand, or other obstructing material into the pipelines. As the work progresses, the interior of the main shall be cleaned of all dirt, jointing material, and superfluous materials of every description.
- c. Joining of piping shall be performed by experienced fusion technicians with a minimum of two (2) years or more experience in field application involving high-density polyethylene pipe.
- d. Handling:
 - i. The pipe must be handled in a way to ensure that it is not gouged or scratched to a depth of more than 10% of the wall thickness.
 - ii. Pipe shall not be bent to a radius of less than 20 diameters at any time during installation.
 - iii. Pipe shall be handled at all times with strapping with a width of at least half the pipe diameter to prevent point damage. No wire rope slings shall be used.
- e. Warning Tape: Non-detectable underground tape for the identification, protection, and warning of buried water pipelines. This tape has a 4 mm overall thickness and is designed to resist underground degradation. The tape is heavy-metal free, non-adhesive, and serves as a durable, highly visible warning device capable of withstanding environmental conditions. The non-detectable tape should have 3-6-inch widths. The warning tape should be laid underground above the water pipeline 0.5 m.

2. Inspection of the system

- a. Inspection of the system shall be as specified in manufacturer instructions and guidelines.

Putting Waterline in Service

There are basically six steps to putting a waterline in service and the Service Provider has to follow these six steps:

1. Flushing

- a. A new pipeline should be thoroughly flushed prior to testing. This will help to prevent any damage to valves or other fittings from any foreign material left in the pipeline. This can be done by opening and closing hydrants, blow-offs, or drains with flow velocities sufficient to flush the foreign material from the pipeline. A minimum of 3ft/s (54.864 m/min.) is suggested.

2. Filling

- a. Slowly fill the pipeline to limit the flow to low velocities that prevent surges and air entrapment. Also, air valves at high points should be opened to allow air to escape as the water level increases inside the pipeline. Temporary valves can be installed. Do not loosen flanges or connections to bleed air from the system. The critical filling rate for pipes with air vents is usually based on 5-15% of the pipe design flow.

3. Testing for Leaks

- a. Leak testing can be done either inside or outside the trench. Because joints for HDPE pipe are fused together, leakage should be zero. Leak tests need to be conducted in accordance with ASTM F2164. For HDPE pipe, a pressure of 1.25 times the design working pressure at the lowest point in the test section is used as the test pressure. Acceptance is found by reducing the test pressure by 10 psi and monitoring the pressure for one hour. If the pressure remains steady – within five percent of the target value – for one hour, leakage is not indicated.

- i. **Pressure Testing Inside the Trench:**

1. Fill the pipeline with water after it has been laid and bleed off any trapped air. Subject the lowest element in the system to a test pressure that is 1.25 times the design pressure and check for any leakage. When, in the opinion of the Purchaser's engineer, local conditions require that the trenches be backfilled immediately after the pipe has been laid, apply the pressure test after backfilling has been completed but not sooner than a time which will allow sufficient curing of any concrete that may have been used. Typical minimum concrete curing times are 36 hours for early strengths and 7 days for normal strengths.
2. The test procedures consist of two steps: the initial expansion and the test phase. When test pressure is applied to a water-filled pipe, the pipe expands. During the initial expansion of the pipe under test, sufficient make-up water must be added to the system at hourly intervals for 3 hours to maintain the test pressure. After about 4 hours, the initial expansion should be complete and the actual test can start.
3. When the test is to begin, the pipe should be full of water and should be subjected to a constant test pressure of 1.25 times the system design pressure. The test phase should not exceed 3 hours, after which time any water deficiency must be replaced and measured. Add and measure the amount of make-up water required to return to the test pressure and compare this to the maximum allowance in the table below.
 - a) An alternate leakage test consists of maintaining the test pressure (described above) over a period of 4 hours and then dropping the pressure by 10 psi (0.69 MPa). If the pressure then remains within 5% of the target value for 1 hour, this indicates there is no leakage in the system.

- ii. **Pressure Testing Outside the Trench:**

1. If specified by the Purchaser's engineer, pressure testing may be conducted prior to pipe installation.
2. After the pipe has been joined, fill it with water, and carefully bleed off any trapped air. Subject the pipe to a hydrostatic test pressure that is 1.25 times the system design pressure for a maximum of 3 hours. During this time, add water periodically to maintain the test pressure as this compensates for the initial stretching of the pipe. The line pressure tightness is determined by visual observation; therefore, it is not necessary to measure the make-up water. Examine every fused joint, understanding that any leakage must be repaired and then retested. Allowance for Expansion Under Test Pressure as detailed in the figure 5.1 below.

FIGURE 5.1

Allowance for Expansion Under Test Pressure:

Nominal Pipe Size inches (1)	U.S. Gals/100 feet of Pipe (2)			Nominal Pipe Size Inches (1)	U.S. Gals/100 feet of Pipe (2)		
	1-Hour	2-Hour	3-Hour		1-Hour	2-Hour	3-Hour
2	0.08	0.12	0.15	20	2.80	5.50	8.00
3	0.10	0.15	0.25	22	3.50	7.00	10.50
4	0.13	0.25	0.40	24	4.50	8.90	13.30
5	0.21	0.41	0.63	28	5.50	11.10	16.80
6	0.30	0.60	0.90	30	6.20	12.60	19.10
8	0.50	1.00	1.50	32	7.00	14.30	21.50
10	0.75	1.30	2.10	36	9.00	18.00	27.00
12	1.10	2.30	3.40	42	12.00	24.00	36.00
14	1.40	2.80	4.20	48	15.00	27.00	43.00
16	1.70	3.30	5.00	54	18.00	30.00	50.00
18	2.20	4.30	6.50				
(1) mm* 0.03937 (2) multiply by 11.53 to convert to liter/100 meters of pipe							

Notes:

1. It shall be the responsibility of the Service Provider to ensure that appropriate safety precautions are observed during hydrostatic testing.
2. High pressure (i.e. >30kPa) air testing is not recommended for safety reasons as the energy stored by compressed air or other gas in a pipeline can be extremely destructive and life-threatening if released accidentally. **Testing by the compressed air will not be accepted under any circumstances.**
3. Under no circumstances shall the total time under test exceed eight (8) hours at 1.25 times the system pressure rating. If the test is not complete within this time limit (due to leakage, equipment failure, etc.), the test section shall be permitted to "relax" for eight (8) hours prior to the next test sequence. Air testing is not recommended. Additional safety precautions may be required than the ones mentioned here.

4. Record Keeping

Test records should include:

- a. Name of person conducting the test, including the Service Provider and contact information
- b. Test medium which is water
- c. Test pressure
- d. Test duration and data
- e. Pressure recording chart of pressure log
- f. Pressure vs. makeup water added chart
- g. Pressure at high and low elevations
- h. Elevation at the point test pressure is measured
- i. Ambient temperature weather conditions
- j. Pipe and valve manufacturers
- k. Pipe specifications and/or standards such as AWWA C906-21
- l. Description of the test section length, location, and components
- m. Description of any leaks, failures, and their repair/disposition
- n. Test times and dates

5. Disinfection

- a. All new potable water pipelines require disinfection in accordance with ANSI/AWWA C651. This should take place after the initial flushing and after pressure testing the line. Disinfecting solutions containing chlorine should not exceed two percent active chlorine. As soon as the normal pipe disinfection period is over, the disinfection solution should be purged and/or neutralized, and the pipeline filled with fresh, clean water. Remember, purging applies to distribution mains as well as to each service line and service connection.

6. Commissioning

The commissioning of a new or repaired pipeline is normally carried out in the following sequence:

1. Cleaning and/or pigging of the pipeline
2. Water filling and pressure test
3. Disinfection
4. Flushing, purging, and/or neutralization
5. Refilling the pipeline
6. Bacteriological sampling and testing
7. Certifying and acceptance
8. Initiating the pipeline into service

Additional information can be found in:

- a. ASTM F2164
- b. AWWA Manual M55,
- c. PPI's *Handbook of Polyethylene Pipe*
- d. PPI's newest technical document, *TN-46*
- e. *Guidance for Field Hydrostatic Testing of High-Density Polyethylene Pressure Pipelines*.

SECTION 6 – WATER TANK

The test galvanized steel tank with the following description and requirements:

- a. It should meet the Steel Tank Institute (STI) standards at the highest standards for common items unless designated.
- b. The galvanization work should be processed by a member of the Galvanizers Association.
- c. A certificate of compliance (ISO 10474) would be available confirming that the galvanization work processed meets the requirements of BS EN ISO 1461: 2009.
- d. All welding processes should be Plasma Arc Welding (PAW) according to ASME B16.25 or equivalent with high-technique machines to ensure an excellent job.
- e. The Service Provider shall offer a new tank structure as supplied by a manufacturer specializing in the design, fabrication, and erection of factory-applied galvanized steel, using PAW for welding. The manufacturer should have successfully implemented similar work for at least 3 years.
- f. The Service Provider shall have the experience and knowledge necessary to furnish and erect the highest quality tank possible. The Service Provider shall be fully responsible for the entire installation including accessories and the final product. Service Providers shall prove that they have successfully implemented similar work specified in this section in at least 3 other projects.
- g. Provide shop drawings with structural designs approved and certified by the factory supply steel panels. Details of fabrications and erection of the tank and its inlets and outlets, sources, and testing results of borrowed material.
- h. Sources and certificates of origin and testing for steel panels and galvanization shall be submitted for approval before installation.

- i. The Service Provider shall warrant the water tank and its durability against defects in workmanship and materials including welding, epoxy, painting, and galvanization for at least 3 years.

SECTION 7 - SUBMERSIBLE PUMP, MOTOR, AND ACCESSORIES

It is the Service Provider's responsibilities to read carefully GRUNDFOS DATA BOOKLET (or any other selected brands by Purchaser's Engineers), visit the Service Provider website, or/and visit the nearest Service Provider's branch, and follow the guidelines and instructions during supply, installation, and testing.

1. Quality Assurance:

- a. The Service Provider shall offer new pumps and electric motors suitable for the depth of the borehole and its discharge.
- b. All materials and components supplied to this project including pumps, motors, controls, sensors, switches, valves, meters, strainers, fittings, shafts, and pipes should pass the quality assurance tests at the factories producing these materials and components in accordance with accepted international standards. The Service Provider shall supply certificates indicating that the materials supplied have passed such tests.
- c. Pump must have the certifications: ISO 9001, ISO 14001 and OHSAS 18001.

2. Submittals:

- a. Provide shop drawings, pump test results, performance curves, warranty, and certificate approving installation for the pump.
- b. Provide shop drawing, performance characteristics, warranty, and certificate approving the installation and suitability of the electric motor for the continuous successful operation of the system.
- c. Provide 4 copies of the Operation and Maintenance manual which contains a complete parts list, recommended maintenance schedules and procedures, and a guide for operation.
- d. Provide complete submittals for the pumping station and all installations that will be implemented at the borehole site, including the pipes, valves, fittings, and electric control unit for approval.

3. Warranty:

- a. The Service Provider shall warrant the system installed and its durability against defects in workmanship and materials for at least 3 years.
- b. The pump manufacturer shall warrant the pump and electric motor being supplied against defects in workmanship and materials for 3 years or 9,000 hours of operation, whichever comes first.

4. Accessories:

- a. The top of the electrical control panel should be 180 cm from the finished floor and its base should be protected by min 20 cm cement block. On/Off push button, emergency button, warning indicator lamps, alarm, digital multi-meter for measuring current, voltages, and power (including ammeter, voltmeter, and frequency meter, etc.), phase failure, overload protection, with selector switch shall be added to the electrical control panel. Cabinet dimensions have to be not less than 80 X 60 X 20 cm. The cabinet should include a soft starter (appropriate for the rated motor power) with all protection relays timers, fuses, main and secondary circuit breakers, bypass contactors, and any other components necessary for the protection of the 3-phase motor and the pump according to the Purchaser's engineer instructions. All circuit breakers must be secured through thermal and magnetic combination action while overload release should be of

thermal type with calibration adjustable between 0.8 and 1.5 of the motor's full current. Relays, circuit breakers, contactors, timers, and any other protection components should be of the best quality such as ABB, Siemens, Schneider, or other approved equivalent type. All items will be placed inside the box.

SAMARITAN'S PURSE