

مشروع المخطط التنظيمي التفصيلي لأراضي المنطقة الحرفية - إقليم البتراء



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المواصفات الفنية

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GENERAL SPECIFICATIONS

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GOVERNMENT PUBLISHED SPECIFICATIONS, REGULATIONS, NOTICES AND CIRCULARS

A. The Works shall be executed and measured in accordance with the following Government specifications, methods of measurements, price inclusions, regulations, notices and circulars:

- (a) Specifications for Construction of Buildings for the Kingdom of Jordan issued by the Ministry of Public Works and Housing 1996.

Volume One : Civil and Architectural Works

Volume Two : Mechanical Works

Volume Three : Electrical Works

- (b) Specifications for Highway and Bridge Construction, 1991, issued by the Ministry of Public Works and Housing.
- (c) General Technical Specification for sewerage works and for water mains distribution systems issued by the Ministry of Water and Irrigation / Water Authority (Latest Edition).
- (d) Jordan Standard Specifications.

B. The Contract shall be deemed to have his own copies and provide the site of the required specifications, standards, regulations, notice and circulars given at (a) and (d) above.

C. In the case of any ambiguity or discrepancy, the provisions of the Project Particular Specification shall prevail over the provisions of the Government Published specifications.

END OF SECTION **GS**

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PART -1- General

1.1 Scope

The Contractor shall supply and deliver to site of work (or as mentioned else where) various kinds and diameters of pipes, fittings, valves,...etc. as specified and required.

Samples of the required materials shall also be submitted to the engineer for his primary approval without any additional cost.

1.2 References

Reference to any national standard or publication as ISO/BS in these specifications is intended to indicate general configuration, type and quality. Goods may be furnished which meet other internationally accepted standard, provided that overall quality shall at least be the standard specified. Supporting documents/ certificates shall be submitted hereto.

1.3 Materials, Standards and Origin

All materials shall comply with the standards mentioned hereinafter and shall be supplied from approved manufacturers and Country of Origin.

The Contractor is requested to submit a list of suppliers that he intends to use together with his tender bid.

The contractor shall also submit for the approval of the engineer, before ordering:

- Type of materials to be used, dimensions, thickness, lengths, shape, weight, class, tolerance limits, and quality.
- Standard to which the item is manufactured.
- Details of specials, adapters, and fittings.

1.4 Potable Water Certification

All pipes, coating, and lining materials shall be certified for potable water use and shall contain no ingredients that may migrate into water in amounts that are considered to be toxic or otherwise dangerous for health.

1.5 Inspection By Engineer

The Engineer reserves the right to inspect goods prior to shipment from supplier's factory. The contractor shall, on request, provide at his own expense all necessary facilities to the Engineer or the authorized representative to carry out such inspection.

This inspection shall be held in accordance with the mentioned standard stated herein.

Inspection or approval by the Engineer of any equipment or materials shall not release the Contractor from any of his obligations under this contract.

1.6 Testing and Marking at Place of Manufacture

The supplier shall at the place of manufacture, test all pipes, fittings and pipe equipment listed in the Bill of Quantities and all necessary jointing material and mark them. The same applies to the contractor for his part of supply, if any. The contractor shall submit a certificate from the manufacturer certifying that all the items have been mill tested and that they have successfully passed the relative tests prescribed by the relative standard specifications.

Any or all materials and manufactured articles supplied by the contractor for use in any of the works, shall if so required by the Engineer be tested in advance at the contractor's expense in accordance with the tests specified in ISO, British or other approved equal standards.

The Materials and workmanship shall be the best of their respective kind and to the approval of the Engineer. In reading of the specification, the words "To the approval of the engineer", shall be deemed to be included in the description of all operations for the due execution of the works.

1.7 Third Party Control

The Contractor shall at his own expense provide a recognized independent third party control to ensure that the pipes, fittings, valves,...etc are all manufactured in accordance with the specific standards and who, among other duties and obligations, shall testify that they have witnessed all mill tests prescribed by the relative standards and the materials manufactured fulfill in every respect the requirement of the contract and who shall check the materials in respect of proper packing and certify the bill of lading. Before signing the contract, the contractor shall inform the Employer of the name of the control party he intends to engage, and obtain the Employer's approval.

1.8 Submittals

The Contractor shall submit:

- Detailed manufacturer's proposals for pipe and fittings manufacture, coating and lining...etc.
- Certified copies of manufacturer's quality controls test results and reports.
- Certified copies of compliance certificates for pipes, fittings and other components.

"This is to certify that the pipes and specials delivered in this consignment comply with the required specifications".

No Payment shall be made in respect of any consignment of pipes and specials in case it is not accompanied by above mentioned certificates.

1.9 Quantity of Pipes, Valves, Fittings and Specials

Before ordering the pipes, the contractor shall make a proper survey of the pipelines and shall make sure of the necessary lengths of each kind of pipe, adapters, fittings, valves, and specials necessary to complete the works.

1.10 Fittings

Fittings unless otherwise specified shall be furnished with a type of joint compatible with the pipe system at the supplier's option. Any adapter necessary to joint fittings to the adjacent pipes, even of different materials, shall be provided by the contractor at no extra cost.

1.11 Toxic Materials

The contractor is prohibited to import or to use any of the “Acrylamide and N-Methylolacrylamide Grouts” or any other toxic or poisonous materials or submaterials used in piping, it's accessories, lining, coating, sealing,...etc, or in various kinds of concrete or in soil in any kind of usage. Any import or usage of the above mentioned materials by the contractor required to be licensed in writing by the employer, otherwise, the contractor shall be subjected to legal pursuance.

1.12 Custom Duties

All materials in this Contract shall not be exempted from customs, import duties, sales tax and other taxes.

PART -2- Pipes

2.1 Ductile Iron Pipes and Fittings

2.1.1 Materials

Ductile iron pipes shall conform to the requirements of “Ductile iron pipes, fittings and accessories for pressure pipelines” (ISO 2531:2009(E)) or other internationally accepted standards which ensure an equal or higher quality than the standard mentioned. All pipework shall be according to the following table unless otherwise stated in the contract documents.

DN (mm)	Pressure Class	Normal Iron Wall Thickness (mm)
100	C40	4.4
125	C40	4.5
150	C40	4.5
200	C40	4.7
250	C40	5.5
300	C40	6.2
350	C30	6.3
400	C30	6.5
450	C30	6.9

2.1.2 Design Conditions Requirements

Each length of pipe shall be designed to withstand the relevant test requirements of ISO 2531:2009(E). Hydrostatic pressure tests shall be performed prior to coating or lining of pipes.

2.1.3 Joints

Ductile iron pipes and fittings shall be manufactured with spigot and socket ends in which the seal is achieved by means of a suitable retained rubber gasket (push-on joint). The gasket shall be of such size and shape that, when joined in accordance with the manufacturer's instructions, it shall provide a positive seal within the manufacturer's range of maximum joint deflection and withdrawal under all combinations of joint and gasket dimensional tolerances and in the range of pressure specified.

The joint shall be capable of accommodating the longitudinal movement resulting from a change in temperature of the pipe of 50 degrees Celsius without loss of water tightness.

The manufacturer's allowable joint deflection shall be not less than

- 5 degrees up to DN 300
- 4 degrees for DN 400
- 3 degrees for DN 500 - DN 600

Where flanged connections are covered by backfill material, then all flanged joints shall be wrapped in Denso Tape or similar approved.

Where connections are in valve chambers then bolts, nuts and washers shall be of stainless steel.

All connecting materials and rubber ring gaskets (steel reinforced) or adaptors shall be provided by the supplier as necessary to connect the valves and any other fittings to the adjoining pipe material, without any additional cost.

“Push –On” joints of any type could be used, that satisfy the pressure as specified in the Tender Documents (test pressure=1.5 * Nominal pressure) and shall be according to ISO 2531:2009(E) or equivalent.

2.1.4 Rubber Ring Gaskets

Unless otherwise indicated rubber ring gaskets for pipe installation shall be vulcanized rubber or vulcanized synthetic rubber in accordance with the international Standard ISO 4633.

Reclaimed rubber may not be used. Sufficient Lubricant as recommended by the pipe manufacturer shall be provided for pipe installation plus five (5) percent as surplus material costs to be included in the unit rates. Incase of extended storage, the pipe manufacturer shall supply instructions for storage limitations and environment.

2.1.5 Fittings

Fittings shall be made of ductile iron (ISO 2531:2009(E)) with push-on flexible joints the pressure class of fittings and special castings shall be class K12 for fittings without branches and K14 for fittings with branches (unless otherwise stated in the contract documents).

2.1.6 Thrust and Thrust Anchors

Bends, tees, tapers, plugs, caps, valves...etc. on ductile iron pipelines or as indicated on drawings shall be well braced against undisturbed soil at the edge of the trench with concrete anchor and thrust blocks. The concrete shall contain 300kgs of cement per cubic meter of concrete and the aggregate well graded and the workmanship shall be in accordance with good practice to the satisfaction of the Engineer. The dimensions and steel reinforcement shall be in accordance with typical sections shown on the detailed drawings or otherwise as directed by the Engineer.

The blocks shall, unless otherwise shown or directed by the engineer, be so placed that the pipe and fitting joints will be accessible for repair.

Where it is not possible to brace against undisturbed soil, suitable fenders shall be arranged as directed by the Engineer.

2.1.7 Pipe Lengths

Pipe lengths shall be 6m in accordance with ISO 2531:2009(E).

2.1.8 Linings

Ductile iron pipes and fittings shall have a blast furnace cement mortar lining. It shall be applied so that it adheres strongly to the pipe. For pipes the lining shall be as specified in ISO 4179 and shall be applied by a centrifugal process. The lining on fittings shall also conform to ISO 4179 and shall be applied by a projection method or by hand application with respect to thickness for straight pipes of the same diameter.

The cement mortar lining thickness for pipes and fittings will be in accordance with ISO 4179. A thickness tolerance of plus 3mm based on the normal value shall be permitted on pipes and plus 6 mm on fittings.

As an alternative the fittings can be internally protected with a bituminous paint (ISO 2531:2009(E)) or with 150 microns minimum thickness special fusion bonded powder epoxy coating.

2.1.9 External Coatings

Pipes shall have an external protection with a metallic zinc coating plus a coal tar coating as per ISO 8179. In addition polyethylene sleeving (to protect the pipes from the surrounding aggressive soil) shall be applied according to AWWA-C-105 or equivalent.

Fittings shall be protected with a coal tar coating and polyethylene sleeving according to AWWA-C-105 or equivalent

2.1.10 Testing and Inspection at Place of Manufacture

Inspection for external appearance, shape, dimensions, and weight shall be carried out on each pipe and fitting. Pipes and fittings shall be coated with care to avoid warping. All pipes and fittings shall be sound and free from surface defects.

Each pipe centrifugally cast shall be subjected to the hydrostatic pressure test as specified in ISO 2531:2009(E). Each fitting and accessory not centrifugally cast shall be subjected to a leaktightness test carried out with water or air as specified in ISO 2531:2009(E). Any pipe or fitting that leaks or does not withstand the test pressure shall be rejected.

Mechanical tests for hardness, tensile strength, and elongation shall be performed on Test pipes selected at random out of castings grouped in lots. Each lot shall be made up of pipes cast successively and shall comprise 200 pipes.

2.1.11 Marking

Each pipe and fitting shall bear the mark of the year of manufacture- nominal diameter- and the word "DUCTILE" on the body of the pipe or fitting. The marks may be cast on painted or cold stamped

2.2 High Density Polyethylene Pipes and Fittings

2.2.1 General

High Density Polyethylene pipes shall comply with ISO 4427 - 1996 (E) and ISO 161 - 1: 1996

The pipes shall be designed for a nominal working pressure Class of PN 16. Pipes shall be jointed with push-fit coupling or compression fittings or electro-fusion, or mechanical fittings.

Pipes designated as PE 100 shall have maximum allowable hydrostatic design stress of (8) MPa and Minimum Required Strength (MRS) of 10 MPa at 50 years and 20 °C, Pipes designated as PE 80 shall have maximum allowable hydrostatic design stress of (6.3) MPa and Minimum Required Strength (MRS) of 8 MPa at 50 years and 20 °C.

The nominal outside diameter and wall thickness for (PE100) pipes are as shown in the following table:

Wall Thickness of Polyethylene Pipes (PE100)

Nominal Outside Diameter (mm)	Wall Thickness (mm)
32	3.0
40	3.7
50	4.6
63	5.8
75	6.8
90	8.2
110	10.0
125	11.4
180	16.4
250	22.7
315	28.6
400	36.3
500	45.4

The nominal outside diameter and wall thickness for (PE80) pipes are as shown in the following table:

Wall Thickness of Polyethylene Pipes (PE80)

Nominal Outside Diameter (mm)	Wall Thickness (mm)
20	2.3
25	2.8

The length of the coiled pipes shall be 50-100 m or straight lengths, if the pipes are to be coiled this must be done at temperature not less than 30°C. For sizes > 63 mm all coils shall be securely banded with tough tape which cannot be removed except by butting.

The minimum diameter of the rollers for coiled pipe should be such that kinking of the pipe is prevented.

The minimum internal diameter of the rollers shall not be less than 24 times the nominal outside diameter of the pipe with a minimum of 600 mm.

The ends of the pipe shall be plugged or covered.

2.2.2 Materials

The pipes shall be manufactured from polyethylene containing only those antioxidants, UV stabilizers and pigments necessary for the manufacture of potable water pipes and shall be either black or black with blue stripes and comply with (ISO 4427).

The Contractor shall provide an approved third party certificate to verify the above. Materials in contact with or likely to come into contact with potable water shall not constitute a toxic hazard, shall not support microbial growth and shall not give rise to unpleasant taste or odor and cloudiness or discoloration of the water. Concentration of substances, chemicals and biological agents leached from materials in contact with potable water, and measurements of the relevant organoleptic /physical parameters shall not exceed the maximum values recommended by the World Health

Organization (WHO, 1984) or as required by the EEC, Council Directive of 15 July 1980, official Journal of the European Communities L 229 pp.1 1 to 29) on the quality of water intended for human consumption, whichever is the more stringent in each case.

Material of unknown composition shall not be used. Only Polyethylene granules that are approved and listed by International approval bodies (i.e. DVGW Germany / DWI UK or equivalent) shall be used in the manufacturing of PE pipes supplied.

Recycled material generated from a manufacturer's own production of pipes should not be used.

Non-metallic products in contact with or likely to come into contact with potable water shall comply with the requirements of BS 6920. 1996

Carbon black content according to ISO 6964.

The pipe manufacturer shall provide evidence of the nominal values of the density and melt flow rate (index) of the raw material.

The density of the raw material (compound) shall not be less than 0.945 gm/cm³. The pipe manufacturer shall provide evidence of the nominal value of the density once at the beginning of the contract upon delivery of material on site, and as instructed by the Engineer.

Density test for raw material and pipes shall be performed according to ISO 1183 or equivalent.

Melt flow rate (MFR) this shall be determined to the method given in ISO 1.133 or equivalent.

MFR shall be less than 1.0 gm/10 min. tested at 190/5 kg, change of (MFR) by processing shall be less than 20%.

2.2.3 Quality

The manufacturer shall operate a quality system conforming to ISO 9001/9002 as applicable.

This shall include a quality plan whereby details and results for each shall be made available to the purchaser or his representative on request. The manufacturer's shall have a written declaration that the polyethylene pipes which they produce for use in public water supplies are manufactured from the granules approved and listed by international approval bodies (i.e. DVGW Germany / DWI UK or equivalent) and that no chemicals or recycled materials are added.

Testing Status

General

Type and batch release tests are carried out by the pipe manufacturer to demonstrate compliance with relevant standard.

a. Type Tests

- Short term hydrostatic strength at 20°C 100 hour according to ISO 1167/1996
- Long term hydrostatic strength at 80°C at 1000 hour according to ISO 1167/1996.
- Long term 80°C stress crack resistance on notched pipe. When tested in accordance with ISO 134/9. Notched pipe test the pipe shall not fail within 1000 hours when pressurized at 9.2 bar (PE 100). This test shall be carried out on SDR 11 pipe.
- Suitability of non-metallic products for use in contact with drinking water intended for Human consumption with regard to the Quality of Water according to BS 6920: 1996.

Hydrostatic Strength

When tested in accordance with ISO 1167, the pipes shall conform to the requirements given in the following table:

Hydrostatic Strength of Pipes (MPa)

Pipe Material	Test Stress 100 Hours at 20°C	Test Stress 165 Hours at 80°C	Test Stress 1000 Hours at 80°C
PE 100	12.4	5.5	5
PE 80	9	4.6	4

For locally manufacture pipes; (regarding 4 tests mentioned above) random samples will be taken from production under a quality assurance system once every 15 months or the

requirements shall be met whenever a change or an introduction of a new or modified raw material (compound) has occurred.

For imported pipes; following the delivery of imported pipes to final destination, for each batch delivered, samples will be taken at random to be tested according to BD 6920 dated 1996.

For tests 1, 2, 3 once per size group.

b. Batch Release Test /Factory Testing

Before releasing any batch of pipe, the supplier is required to carry out basic tests specified below:

- Dimensions and appearance ISO 4427 - 1996.
- Thermal stability ISO 4427.
- Tensile properties, elongation - according to ISO 6259 - 1997.
- Melt flow rate ISO 1133 - 1997.
- Short term 80°C stress crack resistance on notched pipe ISO 13479 - 1997

All type and batch release tests shall be conducted by pipe manufacturer and shall be witnessed and verified by third party.

An approved list of accredited third party agencies is issued by Governmental Tenders Directorate Only recognized third party by GTD may be used by manufacturer or contractor.

Third party shall verify that pipes are produced in compliance with ISO 4427.

No pipe shall be accepted unless all type and batch release tests have been passed.

c. Test after Delivery/ Acceptance Tests

Random Samples of PE pipes shall be taken from site as instructed by the Engineer from both locally manufactured and imported pipes for every lot of 10 km of pipes with diameter 50, 63, 75, 90, and 110, and every 5 ton consignment of pipes with a diameter 40, 32, 25, 20, and 16 mm delivered to site.

Raw material samples shall be supplied by the imported pipes manufacturer, especially for carrying out test 2 mentioned below (MFR) The Engineer may instruct in addition to type and batch releases tests to conduct any or all of the following tests on the samples taken from site.

- Dimensions ISO 4427 - 1996 /ISO 161-1.
- Melting flow ISO 1133 - 1997.
- Tensile proper ties, elongation ISO 6259 - 1997.
- Thermal stability ISO/TR 10837.
- Longitudinal reversion test ISO 2505-1994.

d. Test after Delivery/ Acceptance Tests

The pipelines of transmission and water distribution system and all the joints, fittings and appliances shall be tested for water tightness in the field in accordance with CP 312 part 3 (British standard) as follows:

- Allowable leakage < 3 liter/km/25 mm dia. of pipe/3 bar/24 hours.
- Hydrostatic testing should be carried out at ambient temperature (20°C) otherwise a correction factor (ISO 4427) should be applied to the nominal pressure.
- Test should be applied on sections of length less than (800 m) with uncovered joints.
- Partially back filling to maintain adequate support and anchoring and to avoid floating of pipes during testing with joints exposed and valves in the open position.
- Slow fill with water.
- The filling should be at a rate giving a maximum water velocity of (0.5 m/s) in the pipe to insure no surge and to give the air the necessary time to be released by the installed permanent air valves or installing corporation cocks.
- Leave to reach equilibrium, i.e. the same temperature as the pipe and the surrounding soil and to remove all existing air for the saturation of pipe material, if any.
- Apply test pressure (1.5 the max. nominal working pressure at lowest point) slowly to avoid surge and hold for “one hour”. The system should be isolated from the test pump, i.e., no pumping during the one hour test period allowed. Take test pressure to be 24 bars for transmission pipe – lines, distribution system and for service lines including all couplings and fittings in the open position.
- Apply the equation to decide on the success of test mentioned in item (1) above.
- Finally after completing testing, the line should be emptied slowly to prevent shocks or sudden counteraction of pipes.

2.2.4 Marking

All HDPE pipes shall be indelibly marked at maximum intervals of one meter.

The marking shall show at least the following information:

- Manufacture's name and/or trade mark.
- Dimensions (nominal diameter, wall thickness).
- Material, material class (e g PE 80) and pressure class (e g PN 16).
- Production period (date).
- "Water" to indicate that pipes or fittings intended for potable water.

- Serial number
- Batch number

The pipes and fittings (especially the plastic type) shall be rejected, if the above information for marking is not shown clearly on each piece.

2.2.5 Storage and Handling

Polyethylene pipes tubing and fittings should be stored according to the manufacturer's recommendations.

The following general points should be taken into consideration:

- Contact with burrs or sharp mettle edges on racks,.... etc., should be avoided.
- The ends of pipes should be protected from damage to avoid the risk of unsatisfactory jointing.
- The pipes should be stored under cover and protected from direct sunlight including when stocked at the places of delivery.
- Coils may be stored either on edge or stacked flat one on top of the other, but in either case they should not be allowed to come into contact with hot water or steam pipes and should be kept away from hot surfaces. Coils should not be dragged over rough ground to avoid damaging the pipes.
- Storage of pipes in heated areas exceeding 23°C should be avoided.
- If, due to unsatisfactory storage or handling, a pipe is damaged or kicked, the damage portion should be cut out completely.

2.3 Unplasticized Polyvinyl Chloride Pipes and Fittings

2.3.1 Scope of Work

Furnish all labor, materials, equipment and incidentals required to install and test unplasticized polyvinyl chloride (UPVC) pipe and fittings, complete as shown on the Drawings and as specified herein.

2.3.2 Submittals

- Submit to the Engineer, as provided in shop drawings and schedules of all UPVC pipe and fittings required.
- Submit to the Engineer, within 90 days of the Effective Date of the Agreement the name of the pipe and fitting suppliers and a list of materials to be furnished.
- Test Reports
Prior to each shipment of pipe, submit certified test reports that the pipe for this Contract was manufactured and tested in accordance with the ASTM, AWWA, or other Standards specified herein.

2.3.3 Reference Standards

- American Society for Testing and Materials (ASTM)
 - ❖ ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
 - ❖ ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Electrometric Seals.
 - ❖ ASTM F477 - Standard Specification for Electrometric Seals (Gasket) for Joining Plastic Pipe.
- American Water Works Association (AWWA)
 - ❖ AWWA C651 - Disinfecting Water Mains.
 - ❖ AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in Through 12-in for Water Distribution
- National Sanitation Foundation (NSF)

NSF Standard 14 - Plastic Piping Components and Related Materials
- German Standards (DIN Normen)
 - ❖ DIN 8061 – Unplasticized polyvinyl chloride pipes (General quality requirements and testing)
 - ❖ DIN 8062 – Unplasticized polyvinyl chloride pipes /PVC-U, PVC-HI (Dimensions)

2.3.4 Quality Assurance

- Finished Product Evaluation

Each length of pipe produced shall be checked by production staff for the items listed below. The results of all measurements shall be recorded on production sheets which become part of the manufacturer's permanent records.

- ❖ Pipe in process shall be checked visually, inside and out for cosmetic defects (grooves, pits, hollows, etc).
- ❖ Pipe outside diameter shall be measured using a suitable periphery tape to ensure conformance with ASTM D1785.
- ❖ Pipe wall thickness shall be measured at 12 equally spaced locations around the circumference at both ends of the pipe to ensure conformance with ASTM D1785.
- ❖ Pipe length shall be measured.

- ❖ Pipe marking shall be examined and checked for accuracy.
- ❖ Pipe ends shall be checked to ensure they are cut square and clean.
- Stress Regression Testing

The UPVC pipe manufacturer shall provide certification that stress regression testing has been performed on the specific UPVC resin being utilized in the manufacture of this product. This stress regression testing shall have been done in accordance with Plastic Pipe Institute (PPI) and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 2,000 psi as determined in accordance with PPI procedures.

2.3.5 Warranty

The pipe material manufacturer shall provide an unconditional extended warranty for the pipe covering the cost of materials for repair or replacement plus installation manpower should the pipe fail within the warranty period. The manufacturer's extended warranty shall be for ten years after the final acceptance of the project by the Owner. The manufacturer shall guarantee that the pipe furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the extended warranty. In the event the pipe fails to perform as specified, the pipe manufacturer shall promptly replace defective pipe without any cost to the Owner.

2.3.6 Delivery, Storage and Handling

- Care shall be taken in shipping, handling and laying to avoid damaging the pipe and fittings. Extra care will be necessary during cold weather construction. Any pipe damaged in shipment shall be replaced as directed by the Engineer.
- Any pipe or fitting showing a crack or which has received a blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.
- While stored, pipe shall be adequately supported from below at not more than 1.0 meter intervals to prevent deformation. Pipe shall not be stacked higher than 2.0 meters. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature buildup when exposed to direct sunlight will not be permitted. In the event the pipe fails to perform as specified, the pipe manufacturer shall promptly replace defective pipe without any cost to the Owner.

2.3.7 Materials

- Pipe and fittings shall be manufactured from a UPVC compound which meets the requirements of Type 1, Grade 1, Polyvinyl Chloride as outlined in ASTM

D1784. A Type 1, Grade 1 compound is characterized as having the highest requirements for mechanical properties and chemical resistance.

- The UPVC pipe shall be Schedule 80 or as indicated on the Drawings. The pipes shall conform to the requirements of ASTM D1785 and shall have the nominal dimensions shown on the Drawings.
- Fittings shall conform to the requirements of ASTM D2467 for socket type, joints.
- Pipe shall be furnished in standard laying lengths not exceeding six (6) meters.

2.3.8 Joints

The pipe shall be jointed with solvent cemented joints. Solvent cement shall conform to ASTM D2564 and primer shall conform to ASTM F656.

2.3.9 Marking

Each length of pipe and each fitting shall be marked with the name of the manufacturer, size and class.

2.3.10 Installation

- The UPVC pipe shall be installed in accordance with the instruction of the manufacturer, as shown on the Drawings and as specified herein.
- Pipe shall be laid to lines and grade shown on the Drawings with bedding and backfill as shown on the Drawings. The tape covering the perforations shall be removed during installation. The pipe shall be installed such that perforations face the bottom of trench.
- When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by fabricated plugs, or by other approved means. All plugs shall be OD fitting type plugs. No plugs will be allowed that require insertion of the plug into pipe.
- Pipe shall be stored on clean level ground to prevent undue scratching or gouging. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 10 percent of wall thickness. The interior pipe surface shall be free of cuts, gouges or scratches.
- Sections of pipe with cuts, scratches or gouges deeper than allowed shall not be used.
- The pipe shall be jointed as specified in Paragraph (2.3.8).

- Mechanical connections of the UPVC pipe to auxiliary equipment such as valves, pumps and tanks shall be through flanged connections. Flange connections shall be provided with a full face neoprene gasket.

2.3.11 Testing

- All pipes shall be field tested. The Contractor shall supply all labor, equipment, material, gages, pumps, meters and incidentals required for testing. The Contractor shall do a pressure test for each force main upon completion of the pipe laying and backfilling operations, including placement of any required temporary roadway surfacing.
- All pipes shall be tested at 150 percent of the operating design pressure unless otherwise approved by the Engineer. The test pressure shall be measured at the highest point along the test section by a recording type pressure gauge and a copy of the read out shall be submitted to the Engineer upon completion of the test. All testing shall be conducted in the presence of the Engineer or his designated representative.
- Testing shall be conducted after backfilling has been completed and before placement of permanent surface.
- Testing procedure shall be as follows:
 - ❖ Fill line slowly with water. Maintain flow velocity less than 0.60 meters per second.
 - ❖ Expel air completely from the line during filling and again before applying test pressure. Air shall be expelled by means of taps at points of highest elevation.
 - ❖ Apply test pressure. Measure the quantity of water that must be pumped into the line to maintain pressure within 0.35 bar of the test pressure for a period of 2 hours. This quantity is defined as leakage.
 - ❖ Carefully examine all exposed pipe, fittings and joints during the test.
 - ❖ Upon completion of the test, the pressure shall be bled off from a location other than the point where the pressure is monitored. The pressure drop shall be witnessed by the Engineer at the point where the pressure is being monitored and shall show on the recorded pressure read-out submitted to the Engineer.
 - ❖ No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = SD (p)^{1/2}$$

In which L is the allowable leakage in gallons per hour, S is the length of the pipe tested in feet, D is the nominal diameter in inches, and P is the average test pressure in (psig).

- If any test of pipe laid disclosed leakage greater than that allowed, the Contractor shall, at his own expense, locate and repair the cause of leakage and retest the line.
- All visible leaks are to be repaired regardless of the amount of leakage.

2.3.12 Cleaning

At the conclusion of the work, thoroughly clean all of the new pipelines to remove all dirt, stones, and pieces of wood or other material which may have entered during the construction period. Debris cleaned from the lines shall be removed from the job site. If, after this cleaning, any obstructions remain, they shall be removed.

2.4 Concrete Manholes

2.4.1.1 Scope of Work

Furnish all labor, materials, equipment, and incidentals required to install concrete manholes, frames and covers, manhole rungs, and appurtenances all as shown on the Drawings and as specified herein.

2.4.1.2 Submittals

Submit to the Engineer complete shop-drawings, showing typical details of construction, reinforcing, joints, pipe connections to manhole, manhole rungs, manhole frames, and covers.

Prior to shipment of all materials required by this section, submit certified test reports that the material was manufactured and tested in accordance with all applicable Standards specified herein.

2.4.1.3 Reference Standards

- American Society for Testing and Materials (ASTM): ASTM C478M for manholes.
- British Standards:
 - ❖ B.S. 556 for manhole components
 - ❖ B.S. 497 for cast iron covers and frames

2.4.1.4 Quality Assurance

The quality of all materials, shall be-subjected to inspection and acceptance by the Engineer and the materials shall be rejected at any time on account of failure to meet any of

the Specification requirements; even though samples may have been accepted as satisfactory. Material rejected after delivery to the job shall be marked for identification and shall be removed from the job at once. All materials which have been damaged after delivery will be rejected. Damaged material that has been installed, shall be repaired, if satisfactory to the Engineer, or removed and replaced, entirely at the Contractor's expense.

At the time of inspection, the materials will be carefully examined for compliance with these Specifications, and with the manufacturer's drawings. All manholes shall be inspected for general appearance, dimension, "scratch strength", blisters, cracks, roughness, soundness,...etc. The surface shall be dense and close-textured.

Imperfections in manhole may be repaired to the acceptance of the Engineer. Repairs shall be carefully inspected before final acceptance. Cement mortar used for repairs shall have a minimum compressive strength of 420 kg /cm² at 7 days and 490 kg / cm² at 28 days, when tested in 75 mm by 150 mm cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs subject to the acceptance of the Engineer.

2.4.1.5 Product

- **Manhole Sections**

Portland cement shall be Type V, high sulphate resistant conforming to ASTM C150. All sections shall be cured by an approved method until the concrete compressive strength has attained 200 kg /cm² and not before 7 days after fabrication and/or repair, whichever is longer.

All concrete benching shall be Class I concrete. All encasement shall be Class I concrete. The lean concrete under manholes (blinding) shall be Class III concrete. The concrete used for poured-in-place walls, bases riser sections, top sections and slabs shall be Class I concrete.

Manholes shall be constructed on a blinding of Class III concrete. Walls, bottom and top slabs shall be at least the thickness and reinforced as shown on the Drawings. A locking manhole cover and frame shall be installed in the top slab as shown on the Drawings and as specified within this section.

All invert channels through manholes shall be constructed of Class I concrete and shall be properly formed to the sizes, cross sections, grades and shapes shown on the Drawings, specified or ordered. Benches shall be built up to the heights called for on the Drawings, specified or ordered and given a uniform wood float finish. Care shall be taken to slope all benches for proper drainage to the invert channel.

Sewer pipes connecting to manholes shall be installed true to the line and grade shown, specified or ordered for the adjacent sewer. Where required for future connections, concrete or ductile iron pipe stubs with approved watertight plugs shall be installed in manholes at the proper locations.

The final grading of the manholes shall be as shown on the Drawings or as directed by the Engineer's Representative. Manholes in paved areas shall be constructed to meet the final surface grade. Manholes shall not project above finished roadway pavements and shall be adjusted so that the covers and frames are 1 cm or less

below the finished pavement. A reinforced Class I concrete slab shall be cast in-situ around the frame for encasement and protection in unsurfaced roads and agricultural areas.

The Contractor shall be solely responsible for the proper height of all manholes. The Contractor is cautioned that the Engineer's Representative's review of shop drawings for manhole components will be general in nature, and the Contractor shall adjust any manhole height to meet field conditions for final grading.

- **Manhole Frame and Cover**

Note: figures in the text in relation with technical drawing

Manhole cover will be in Ductile Cast Iron, according to ISO 1083, and will be complying to EN124 Standard, class D400 (40 tonnes of resistance minimum).

This compliance will be certified by an Authorised and Independent Third Party, and the cover will be so badged with the logo of the Third Party (such as “NF”, granted by AFAQ/AFNOR Certification).

It will have to be cast by a manufacture complying to the ISO 9001: 2000 Standard

Frame will have to be moulded with wide anchoring holes **(2)** , at least 16, to allow effective and durable bedding.

Frame will have at least 18 strong ribs **(3)** , to provide mastered frame profile capable to withstand traffic stresses.

The frame height will be of 100 mm minimum, square shape, with outside dimension of at least 850 mm for a good settlement of the manhole and a right behaviour under traffic stresses.

The clear opening of the frame will be of minimum 600 mm

A sound-proofing gasket in composite material (such as PE+PP) will be installed on the frame to support abrasion and crushing when in function. It will be clamped on the frame **(9)** , with a specific shape to avoid it moves out from the frame

For an ergonomic opening and lifting once unlocked, the cover will be hinged, with an integrally ductile cast hinge **(1)**. This hinge will be integral part of the cover, so it resists as well as the cover to corrosion, vandalism and traffic impact

The cover when opened will have to stay in 130 ° position **(4)** to avoid any accidental self closure on workers.

The cover will be round shape, and non ventilated

An elastic spring bar **(5)** , cast integrally with the cover, will be active that is to say designed to bring a permanent tension between that spring bar, and the cover positioning lugs. It so will provide a dynamic stability of the cover thanks to 3 points of contact.

Furthermore, the spring bar keeps the cover held against the gasket, preventing from rocking avoiding any cracking in the bedding.

The elastic spring bar will be such that it will be automatically closed by any load (traffic or pedestrian) when coming over the cover

This spring bar will nevertheless be flexible enough to open by itself when over pressure in the network, and will so avoid any damage in the network (shaft and pipes)

The unlocking of the cover will be allowed by lever effect in the opening box (6) , located on the side of the frame, and will be permitted with usual tools such as pickaxe or bar. It will be potentially opened via a single operation.

An optional locking mechanism to prevent from any intrusion in the network will be foreseen on the cast cover, thanks to a punch able recessed area (7)

The Manhole cover should be ready to install in case of need An anti-theft device (8) , such as a specific spline, cast in ductile iron, to be installed in the frame hinge box, to avoid releasing the cover out of the frame.

A badging of Aqaba Water Company (AWC) Logo should be casted on the manhole cover.

- **Manhole Rings**

Manhole rings shall be of cast iron with a minimum dimensions as shown in the drawings equivalent to Neenah Catalogue No. R-1980-0 or local equivalent-for cast-in-place concrete manholes and a Neenah catalogue No. R-1981-N or local equivalent for precast concrete manholes.

2.4.1.6 Pipe Connections to Manhole

Manhole pipe connections shall be accomplished in the following ways:

- For making connection to existing manholes, tapered hole shall be filled with non-shrink waterproof grout after the pipe is inserted. The grout is placed carefully to completely fill around the pipe. If this method is used, place concrete encasement outside manhole wall.
- For cast-in-place sewer manhole bases, the bell and spigot pipelines shall be cast integrally with the base and encased or cradled to the limits shown on the Drawings.

2.4.1.7 Installation

- Manholes shall be constructed to the dimensions shown on the Drawings and as specified in these Specifications.
- The cast-in-place manholes shall be placed and bedded as shown on the Drawings.
- Holes in the concrete barrel sections required for handling or other purposes shall be plugged with a non-shrinking grout or non-shrinking grout in combination with concrete plugs, and finished flush on the inside.
- **Manhole Rung Installation**
Cast iron manhole rungs shall be grouted into manholes on 300 mm centers. Rungs shall be grouted into the sections immediately after the sections are cast and placed in for curing. Holes shall be filled with non-shrink grout.
- **Damp proofing**
Outer surfaces of cast-in place manholes shall be given two (2) coats of bituminous damp proofing at the rate of 1 m² per liter as directed by the Engineer and in accordance with manufacturer's instructions.

2.4.1.8 Leakage Tests

After backfilling, the Engineer's representative will make a complete visual inspection of the manhole. Any joint showing appreciable amounts of leakage or any other defect shall be plugged or repaired to the satisfaction of the Engineer. Manhole leakage shall not exceed 0.35 liters/10min/m height/m diameter.

2.4.1.9 Cleaning

All new manholes shall be thoroughly cleaned of all silt, debris and foreign matter of any kind, prior to final inspection.

PART -3- Concrete and Reinforced Concrete

3.1 Material and Workmanship

All materials used in the works shall be the best of their kind and shall conform in quality and treatment to the conditions herein specified. The contractor shall submit to the engineer when required and at his own expense representative samples of all materials to be used in the works.

All construction shall be executed by competent workmen in accordance with the best modern practice and to the satisfaction of the Engineer. All contractors' site staff must be of first class. Should the Engineer so request in writing, the contractor shall immediately replace any of such staff who is considered to be incompetent.

3.2 Cement

Cement of type ordinary Portland cement according to Jordan Standard specification No. 30-1993 shall be used.

Cement shall be delivered to the site of works in the original sealed and branded bags. No cement shall be used which has been manufactured six (6) months prior to its proposed use on site. No cement shall be used which has been in storage for more than three (3) months unless tested before use and found satisfactory in accordance with J.S.S. Cement shall be stored on site in approved covered sheds with well drained raised floors.

The Engineers may refuse any cement which contains air set or hardened lumps, repowdered air-set materials, foreign matter or contamination or which in his opinion is unsatisfactory for any reason whatsoever.

3.3 Aggregate of Concrete

Fine and coarse aggregates shall be supplied from an approved source and shall comply with Jordan standard specification No. 96.1993.

3.4 Grading of the Combined Aggregate

The grading of the combined aggregate shall be suitable for making a dense concrete of appropriate workability.

The proportions of fine to coarse aggregate to be used in each class of concrete shall be approved by the engineer.

For this purpose samples of aggregate proposed by the Contractor for use in the works shall be submitted to the Engineer for testing. The Engineer will carry out all necessary tests at the contractor's expense.

3.5 Water

Water for mixing concrete shall be drawn from the public supply at the contractor's expense. The water shall enter the mixers at the lowest possible temperature and shall not exceed 30° C.

3.6 Concrete Classes

- The various classes of concrete to be used in the works are as shown below:

Class of Concrete	Estimated content of cement kg/m ³ of concrete	Proposed proportions of aggregate %coarse %fine	Max permissible water cement ratio l/kg of cement	Cube strength test : kg/cm ² 28 days after mixing works
I	400	60	0.48	300 watertight
III	250-300	40 60	0.55	200

- The different classes of concrete shall be used as follows:

Concrete class I, watertight for manholes, chambers, thrust blocks, encasements, benching or where specifically directed by the Engineer, Concrete class III for fill below pipes in trenches, blinding, street-crossing or as indicated on drawings.

3.7 Mixing and Placing of Concrete

All concrete shall be machine mixed with approved machines. The location of the mixing plants shall be agreed on with the Engineer and the contractor must submit to the engineer for approval before erection of any mixing plant his proposed arrangements for the storing of aggregates, batching and mixing of the concrete.

The concrete shall be gently placed in position and shall not have free fall of more than 1 meter.

The concrete must be placed in its final position in the works within 30 minutes after the cement being wetted.

Concrete shall normally be consolidated by means of mechanical vibrators. However, if the concrete quantity to be placed in one location is less than one cubic meter consolidation may be achieved by means of "pumping" the concrete in the molds by using a wooden stick. The slump for concrete thus consolidated must be fairly high and the cement quantity increased accordingly to achieve specified strength.

3.8 Curing

Even though the concrete quantities poured at each location are small, all concrete must be continuously kept moist for a period of at least 7 days after placing.

3.9 Steel Reinforcement

Steel reinforcement except for stirrups shall be deformed bars of high tensile billet –steel with yield strength of not less than 4200kg/cm². Stirrups shall be of mild steel with an ultimate tensile strength of not less than 3700 kg/cm². Deformed bars shall not be provided with hooks. They shall be bent to an inner radius of not less than ten times the diameter of the bar

Cleaning, placing, fixing, testing,...etc, shall be made in accordance with J.S.S. 441, 442/1994.

3.10 Concrete Tests

Tests of concrete shall be carried out in accordance with B.S 1881. Preliminary tests shall be made by the contractor to determine suitable mixes. Routine tests shall be made for cube strength with 6 cubes of concrete from each concreting location taken in such manner as may be specified by the Engineer. The first three cubes shall be tested after 7 days and if these cubes show an average strength below 80 per cent of the required strength after 28 days the second three cubes shall be tested after 28 days.

If the Strength of the second three cubes does not meet the requirements, the concrete structure the cubes represent shall be core tested, if the cores' test results do not meet the requirements, then the ministry of public works' specs and procedures regarding these results shall be applied. All remedies and associated costs shall be at the expenses of the contractor

All costs in connection with the tests shall be at the contractor's own expense.

3.11 Formwork Material

Timber for use in form work shall be of good quality, nonabsorbent and free from loose knots, shake and warped surfaces. Formwork for concrete shall be constructed in either of the following materials as approved by the engineer:

- Metal formwork with accurately aligned and close fitting joints.
- Plywood sixteen (16) mm thick on boarded timber.
- Other formwork systems suitable for the intended purpose and approved by the engineer.

All formwork and form faces shall be non-absorbent, resistant to water, and be fixed and jointed in such a manner as to give grout-tight, perfectly smooth and even –finished surfaces (Fair Face).

PART -4- Valves and Fittings

4.1 General

All valves, on any type of pipeline must be jointed to the pipe by flanges and shall have a testing pressure of 1.5 times the nominal pressure.

Each valve shall be provided with a dismantling joint, for convenient installation or re-installation of valves or similar items.

All valves shall be of the non – rising stem type, and shall be capable to withstand the specified test pressure without taking.

The handwheel of all valves (including those which incorporate gear) shall be arranged for clockwise closing. All handwheels shall have, in their periphery, the words OPEN and SHUT and appropriately positioned arrows.

When valves have inaccessible positions, extension spindles shall be fitted to suit the situation.

Each valve shall be supported with reinforced concrete thrust block without any extra payment.

The contractor shall submit a certificate from the manufacturer certifying that all valves have been mill tested and that they have successfully passed the tested prescribed by the relative standard specifications.

All pipe fittings and valves shall be supplied by the contractor and be suitable for buried installations.

Fittings unless otherwise specified shall be furnished with a type of joint compatible with the pipe system at the supplier's option. Any adaptors necessary to join fittings to the adjacent pipes shall be provided within the contract at no extra charges.

All valves shall be supplied by the contractor and shall be placed as follows:

- Valves of 200 mm (8 inch) nominal diameter and larger shall be placed in chambers as shown on the drawings.
- Valves of less than 200 mm (8 inch) N.D shall be placed in surface boxes which should be supported by concrete as shown on the drawings.
- Surface box laid on PE piping system shall have a square or hexagonal lid box to differentiate from ordinary valve surface box which have a circular lid design.

Catalogues and leaflets with the necessary information, technical data, cross-sectional drawings showing the component parts and materials of the various valves and other materials intended to be used in the works shall submitted with the tender.

All valves and fittings used for water network shall comply with water application, same for wastewater network.

4.2 Gate Valves

Valves of maximum working pressure up to (25) bars, the valve shall comply with (B.S 5163) or equivalent standard.

Valves of maximum working pressure greater than (25) bars, the valves should be flange ended, cast iron globe type and shall comply with (BS. 5160) or equivalent standard.

Valves to be installed in concrete chambers, shall where necessary be of the short type to gain space. The valves shall be of-the double flange type, utilizing the same differential pressure across the gate with screw less bonnet connection, pressure loaded and pressure sealed with easy assembly and dismantling of functional parts or otherwise with: stainless steel connected bonnet.

All connecting material and rubber ring gaskets or adapters shall be provided by the supplier as necessary to connect the valve with the adjoining pipe material, without any additional cost.

Surface protection of valve internal and external by plastic enamel coat (epoxy resin) applied by electro-static spray process.

Buried valves shall be supplied with stem nuts coupling, sleeves and extension spindles of 0.5m and 1.00 m length according to the requirements on site.

If necessary spindles have to be shortened. The top of the extension spindle (Key rod) shall be fitted with cast iron surface box according to DIN 4056 with pre-cast concrete supports. The spindle itself shall be protected by a suitable PE or PVC guard tube including tube covers. Valves to be installed above ground shall be provided with hand wheels. All valves shall be supported by concrete blocks.

Valves with diameter ≥ 200 shall be installed in concrete valve chambers according to the standard drawings. These valves shall be operated by supplied hand wheels inside the valve chamber.

Additionally these valves shall be equipped with extension spindles and surface boxes, as described above, and as shown as a general detail on the standard boxes, as described above, and as shown as a general detail on the standard Drawings, Extension spindles to be connected to the handwheels by stem unit couplings.

All accessories necessary (as described before) for the above mentioned valve types shall be included in the relevant unit rates for those particular valves.

Min Diameter of handwheels for	DN 250 : 500 mm
	DN 200 : 400 mm
	DN 150 : 315 mm
	DN 125 : 315 mm
	DN 100 : 315 mm

Valves with diameter < 200 mm shall be installed in the ground according to the standard Drawings.

One operating key shall be provided for every 10 valves delivered. One extra hand wheel shall be provided for every 10 valves of 100, 150 and 250 mm dia delivered. The keys and hand wheels shall be included in the unit rates for the valves.

4.3 Air Valves

Air valves shall be of the combined type with a larger venting cross section, which permits passage of large volumes of air for vacuum breaking and venting on starting up and closing down, and with a small venting cross section for release of small volumes of air under full internal pressure.

Where shown on the drawings, automatic air vacuum and air release valves shall be supplied with double orifice air valves with both small and large orifices and an isolating valve to permit inspection of the valve without shutting off the main. The air valves shall be fitted with floats made of stainless steel with rubber seating complying with DIN 17440, suitable for operation in tropical climates. A minimum of one float for each size of valve shall be included in the delivery and in the unit rates for the air valves.

The valve casings and covers shall be made of cast iron conforming to DIN 1693. Valve spindles shall be made of stainless steel 20 C13, according to DIN 17440.

Air valves shall be designed to limit water hammer effects in water network, and all shall conform to the working pressures of the pipe.

All air valves shall be supplied with flanged isolating valve separated from the air valve body.

The isolating valves and all fittings required to install the ARV shall be included in the unit rates of the air valves.

Air valves shall be installed as follows:

- For black steel main pipelines, the contractor shall cut a hole in the transmission pipeline and install and weld a black steel pipe of suitable length and diameter provided with the appropriate slip - on flange with a neck to suit the flanged air valve
- For ductile iron main pipelines, the contractor shall install a suitable flange tee (T) and install a pipe of suitable length and diameter in order to install the A.V provided with a neck to suit the flanged air valve.
- The welding and the air valve pipes welded joints together with flanged joints shall be properly protected in accordance with the specifications.
- For HDPE pipelines, the contractor shall install a suitable fitting to install the air valve.

4.4 Washout Valves

The types of Wash-Out specified for this contract, whether in concrete chambers or buried type are as shown on the Standard Drawings. All washouts will be constructed as indicated on these Standard Drawings or as instructed by the Engineer.

- For black steel main pipelines, the contractor shall cut a hole tangentially at the lower part of the transmission main, install and weld a steel pipe of suitable length and diameter provided with a slip - on welding neck flange to suit the flanged washout valve.
- For Ductile Iron main pipelines, the contractor shall install a suitable flanged tee to install the flanged washout valve.

The washout pipes shall be extended to such a length and reach discharge area as is required for every particular site condition as not to flood the trenches or cause any damage to the surrounding area.

- The welding and the W.O pipes welded joints together with flanged joints of the valves shall be properly protected in accordance with the specifications.
- For HDPE pipelines, the contractor shall install a suitable fitting to install the washout valve.

The unit price of washout pipelines shall also include all concrete and other works at the end of W.O pipelines (outlet structure with riprap) as shown on the drawings.

4.5 Surface Boxes

Cast iron surface boxes with round lid according to DIN 4056 shall be supplied and installed for operation of valves as described under gate valves. Surface boxes shall be suitable for a 100 KN load.

The surface box made of cast iron or ductile iron shall be situated at ground level on the road or pavement.

The hinge of the lid shall be of non-corrosive material. Circular lids shall be used for valves (gate and butterfly).

Surface boxes shall have a cold applied bituminous black paint coating.

Surface boxes shall be supported by reinforced concrete to suit the surface box as shown on the drawings.

4.6 Dismantling Joints

Dismantling joint shall be provided and installed with each valve and/or where indicated on the drawings for convenient installation or re-installation of valves or similar items.

For prevention of any move of the pipe joints adjacent to closed valves, dismantling joints shall be provided in general by restrained dismantling pieces (short version) according to DIN 2541 or DIN 2547 or flanged adapters as indicated on drawings or as directed by the Engineer.

Body and glands of steel welded dismantling pieces shall be of pressure similar to the valve of pipeline connected to it, with bolts and nuts of stainless steel. Surface protection by epoxy resin coating or equivalent quality. Rubber sealing rings made of perbunan material, nitrile rubber or equivalent quality, shall be used

4.7 Accessories for House Connections

Accessories to be used in house/service connections shall conform to the specifications given hereunder:

4.7.1 Ferrule

Ferrule cock shall be designed with single outlet push fit suitable for HDPE service line connections from mains. They shall be screw down type that can take the place of a stopcock and designed as a main stem with a swivel outlet at 90° with control of water flow via a threaded inner plug. The cock shall have inlets with taper made threads to (B.S21 and ISO 7/1).

The ferrule cock shall be easily "shut off" by means of an extended spindle attached to the inner plug.

The design of the ferrule shall permit service line installation via dry/under pressure machines which mount on to the ferrule /saddle assembly.

The screw down ferrule cock shall be manufactured of Gunmetal complying with (B.S 1400-LG2 or ISO R 1338) with minimum percentage of zinc complete with nitrile rubber washers in accordance with (B.S 2494).

4.7.2 Saddle Strap

Saddles are required to be used as indicated on Drawings for service lines connections.

Saddles shall be fixed around the existing and the proposed main distribution lines (mostly Black Steel Pipes) of diameters equal or greater than 100 mm (4"). The Saddle shall be of single strap design and in two parts, top and bottom-bolted at both sides. Saddles shall be design to suit tapping a hole under pressure. The inside corners of the saddle strap should be rounded to prevent digging into the pipes. The saddles shall be manufactured from gunmetal to (B.S 1400-LG2 or ISO R 1338). The saddles shall be supplied complete with the following:

- Bolts and nuts of stainless steel to (ISO 3506) or equivalents. Bolts head shall be clearly marked with the manufacturer's name or his identification mark.

- Nitrile rubber sealing "O", suitable for service condition to be fixed between the disc and the pipe in groove in accordance with (B.S 2494).

The saddles shall be suitable for use with screw down ferrules. Saddles shall be tapped for internal pipe threads in accordance with (ISO 7/1 and B.S 21).

4.7.3 Self Tapping Ferrule and Saddle

Completely self contained integral cutter self tapping ferrule and saddle shall be used to connect the house connections directly to the (HDPE) service lines or /and loops. The service saddle should be bolted around the service line and the house connection connected via the ferrule pushfit outlet of 360° alignment. The tapping may be dry or under pressure.

The self tapping ferrule and saddle shall be manufactured from gunmetal to (B.S 1400 LG-2 or ISO 1338) supplied completely with the following:

- Bolts and nuts of stainless steel to (ISO 3506) or equivalents. Bolts head shall be clearly marked with the manufacturer's name or his identification mark.
- Nitrile rubber sealing "O", suitable for service condition to be fixed between the pipe and the saddle in groove in accordance with (B.S 2494).
- Self drilling cutter of Aluminum Bronze in accordance with (B.S 2874) or and approved international standards.

PART -5- Trenching, Backfilling and Compaction

5.1 Scope of Work

- Furnish all labor, materials, equipment and incidentals necessary to perform all trenching for pipelines and appurtenances, including drainage, filling, backfilling, disposal of surplus material and restoration of trench surfaces and easements.
- Excavation shall extend to the width and depth shown on the Drawings or as specified and shall provide suitable room for installing pipe, structures and appurtenances
- The Contractor shall furnish and place all sheeting, bracing and supports and shall remove from the excavation all materials which the Engineer may deem unsuitable for backfilling. The bottom of the excavation shall be firm, dry and in all respects, acceptable. If conditions warrant, the Contractor may be ordered to deposit gravel for pipe bedding, or gravel refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatever. The length of open trench shall be related-closely to the rate of pipe laying. All excavation shall be made in open trenches.
- All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P). Where conflict between OSHA and other specifications exists, the more stringent requirements shall apply.
- Unless otherwise specified, all compaction shall be at least 95 percent of the maximum dry density in accordance with ASTM D1557, Method D.
- Prior to the start of work the Contractor is required to submit his proposed method of backfilling and compaction to the Engineer for review.

5.2 Excavation Support System Design Criteria

- The Contractor has sole responsibility for the adequacy of excavation support systems, preventing damage to adjacent structures and other work, and job safety. Excavation support systems shall be designed to support the sides of excavations such that damage to adjacent structures by undermining or excessive ground movements outside the excavation is prevented.
- Excavation support system design shall account for all soil and water pressures and surcharges from traffic, adjacent structures, material stockpiles, construction equipment or any other loads which will be imposed on the system at any stage of excavation and bracing and construction of the Work.
- Design the excavation support system for staged removal of bracing in accordance with the sequence of concrete placement and backfilling.

- Design calculations and shop drawings for the excavation support system shall be prepared by an experienced professional engineer employed by or retained by the Contractor.
- Review of the Contractor's shop drawings design calculations and methods of construction by the Engineer does not relieve the contractor of sole responsibility for the adequacy of excavation support systems, preventing damage to adjacent structures and other work, and job safety.
- The qualifications and experience record of the Contractor's designer of excavation support system(s) shall be subject to approval by the Engineer. The designer of the excavation support system shall have a total of 10 years experience with a minimum of 2 years experience with excavation support system design.

5.3 Testing and Monitoring

In-place soil compaction tests shall be performed by an independent testing laboratory employed by and at the expense of the Contractor.

The Engineer shall review all testing procedures and equipment for conformance with ASTM procedures. In the event the independent laboratory is not performing required testing to the satisfaction of the Engineer, the Engineer shall direct the Contractor to discontinue the services of the independent laboratory and, at no cost to the Owner, employ the services of another laboratory acceptable to the Engineer.

Methods of Testing: The following tests will be required.

- Gradation tests shall be in accordance with ASTM D422 and ASTM D2217. One test shall be required for each type of backfill material at average intervals not to exceed 500 meters of trench length.
- Maximum density and optimum moisture content determination for common Fill and Select Common Fill shall be in accordance with ASTM D1557. One test shall be required for each type of backfill material at average intervals not to exceed 500 meters of trench length.
- For area fills, an in-place field density test will be required for each 1000 m³ of material placed. For pipelines, one in-place density test will be required at average intervals not exceed 100 meters of trench length.
- In-place field density test procedures shall provide for immediate on-site determination of percent compaction. Results are to be reported on the same day to the Engineer.

5.4 Safety, Protection of Life and Property

- The Contractor has sole responsibility for preventing damage to adjacent structures and other work, and for job safety during execution of the Work. Excavation support systems where required, shall be designed to support the sides

of excavations such that damage to adjacent structures by undermining or excessive ground movements outside the excavation is prevented.

- Trench sides may be sloped or battered only in those areas where the increased trench width will not interfere with existing surface features or the limits of permanent rights-of-way. Trench sides shall be of sufficient slope to prevent caving or sliding. Slopes shall not extend lower than the limits shown on the Drawings. Use of sloped or battered trench sides is subjected to acceptance of the Engineer.
- The Contractor shall furnish, put in place, and maintain such sheeting and bracing as may be required to support the sides of excavations, to prevent any movement which could any way diminish the width of the excavation below that necessary for proper construction, and to protect adjacent structures from undermining or other damage. Use of open sheeting is not acceptable. The sheeting and bracing installed shall be in conformity with the design, and certification of this shall be provided by the sheeting and bracing design engineer.

Sheeting and bracing design shall account, for all soil and water pressures and surcharges from traffic, adjacent structures, material stockpiles, construction equipment or any other loads which will be imposed on the system at any stage of excavation and bracing and construction of the Work.

5.5 Excavation Restrictions

- Access for pedestrians shall be maintained to structures and residences adjacent to the work at-all-times during construction.
- Utilities servicing structures and residences adjacent to the Work shall be maintained at all times during construction.
- Excavation shall proceed "in-the-dry".
- In heavily congested areas and where maintaining traffic [one way, each way] is difficult, open trenches shall be limited to no more than 50 meters.

5.6 Other Requirements and Restrictions

- The Contractor shall adhere to the applicable requirements of all ordinances, codes and regulations of authorities having jurisdiction over safety of excavations.
- Active utility lines damaged in the course of construction operations shall be repaired by the Contractor or replaced immediately at no cost to the Employer.
- The Contractor shall conduct earthwork operations to control dust, noise, vibrations and maintain clean streets accessing the site.

5.7 Materials

5.7.1 Materials for Excavation Support

- Steel Sheet Piles: A continuous interlocking type, ASTM A328 standard grade, non-damaged, with cross-sections selected for intended use.
- Soldier Piles and Bracing: Structural steel for use as soldier piles and in bracing systems shall conform to the current edition of "AISC" Specification for the Design, Fabrication and Erection of Structural Steel for Buildings".
- Timber: Structural grade having a minimum allowable working stress of 1100 psi. Basis for determination of minimum allowable working stress shall be ASTM D2555 and ASTM D245.
- Welding: Welding shall conform to American Welding Society Code D1.0 for Welding in Building Construction.
- Trench Box: A steel box designed with suitable wall thickness and cross bracing for excavations typical to this project.

5.7.2 Earth Materials

- Common Fill

Common Fill shall consist of mineral soil substantially free from organic materials, loam, wood, trash and other objectionable materials which may be compressible or which cannot be properly compacted. Common Fill shall not contain stones larger than 100 mm in largest dimension and shall be well graded. Common Fill shall not contain stone blocks, broken concrete, masonry rubble or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling.

- Select Backfill Material

Select backfill material for trenches under dirt roads footpaths and side walks with plasticity index less than 10 as determined by BS 1377 with a maximum dry density greater than 1.6 gram/cm³ according to Standard Proctor density and ASTM D1557 Modified Proctor. In addition it shall not contain stones larger than 50 mm in largest dimension.

- Sand UPVC and HDPE Pipes Bedding

❖ Sand for ductile iron pipe embedment shall consist of natural silica sand or, subject to approval of the Engineer's Representative, other inert materials with similar characteristics having durable particles.

- ❖ Sand from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction without permission from the Engineer's Representative.
- ❖ Sand shall be uniformly graded and shall conform to the following grading requirements.

Sieve Size in mm By Weight (AASHTO T27)	Percent Passing (%)
9.5	100
4.76	95-100
1.19	45-80
0.30	10-30
0.15	2-20

- ❖ Sand shall not contain deleterious substances in excess of the following percentages:

AASHTO Test Method By Weight	Material No.	Percent Passing (%)
Clay Lumps	T112	1
Coal and lignite	T113	1
Material Passing No. 200 sieve	T11	3

Total deleterious substances including the above and shale, alkali, mica, coated grains, and soft and flaky particles shall not exceed 6 percent-by weight.

- ❖ The Contractor shall submit to the Engineer's Representative samples of proposed Sand. The proposed material must receive the approval of the Engineer's Representative prior to use on the Project.
- Select Graded Aggregate for Under Road Surfaces
 - ❖ The top 300 mm of pipe trench under road surfaces and pavements shall be filled, watered and compacted with select graded aggregate.
 - ❖ Select graded aggregate for first 300 mm under pavement shall be sound, naturally occurring material or angular crushed stone, clean and free from organic matter and unsuitable material or other deleterious substances and in such condition that it can' be readily compacted under watering and rolling to form a firm and stable layer. It shall be graded as follows:

Sieve Size in (mm)	Percent Passing (%)
37.5	100
25.0	60-100
19.0	55-85
4.8	35-60
2.4	25-50
0.425	15-30
0.075	8-15

- Graded Aggregate for Trench Backfilling
 - ❖ Backfilling 300 mm under the pavement to the top of the pipe bedding shall be with graded aggregate.
 - ❖ Graded aggregate for the area 300 mm under pavement to the top of the pipe bedding shall be sound, naturally occurring material or angular crushed stone, clean and free from organic matter and un-suitable material or other deleterious substances and in such condition that it can be readily compacted under watering and rolling to form a firm and stable layer.

Sieve Size in (mm)	Percent Passing (%)
50	100
25	55-85
4.8	30-65
0.425	8-40
0.075	0-15

- Structural Fill

Structural fill shall be used under pipeline structures if existing material is unsuitable. Structural Fill shall be clean and free from loam, rubbish, wood, trash or other objectionable materials which cannot be properly compacted. Structural Fill shall be graded within the following limits:

Sieve Size in (mm)	Percent Passing (%)
20.0	100
16.0	80-95
12.5	50-80
8.0	30-70
4.8	20-50
0.50	5-20
0.15	0-10

Where Structural Fill is used it shall be placed in 150 mm thick lifts with each lift compacted to at least 95 percent of maximum dry density as determined by ASTM D1557.

5.8 Execution

5.8.1 Site Preparation

Ground surfaces within the construction areas of the working site shall be cleaned of all brush, debris, and surface vegetation. Stumps and roots shall be completely grubbed and removed. Matted roots shall be removed regardless of size. Surface vegetation shall be removed complete with roots to a depth of not less than 100 mm below the ground surface.

All areas and all trees shown on the Drawings or designated by the Engineer to remain, shall be protected from damage by all construction operations. Permissions should be

obtained from the owners and acceptance of the Engineer for Additional trees or groups of trees which should be removed to carry out the work.

Clearing operations shall be conducted in a manner to prevent falling trees from damaging trees designated to remain. Protection of trees designated to be preserved shall include barrier or fence protection, trimming of trees and preventing stockpiled material from covering tree trunks.

All combustible and other waste material resulting from construction operations shall be removed within the limits shown and disposed of by and at the expense of the Contractor. Open burning is not permitted.

Remove and stockpile all topsoil within a minimum depth of 100 mm from surfaces to be excavated, from fills, and from any other areas on the site of the Work where the original ground surface will be covered or damaged. After all other Work has been completed in each area, topsoil shall be placed and graded to the satisfaction of the Engineer.

5.8.2 Trench Excavation

Trench excavation shall include material of every description and of whatever substance encountered. Pavement shall be cut with a saw, wheel or pneumatic chisel along straight lines before excavating.

The Contractor shall strip and stockpile topsoil from agricultural or vegetated areas crossed by trenches. At the Contractor's option, topsoil may be otherwise disposed of and replaced, when required, with approved topsoil of equal quality.

While excavating and backfilling is in progress, traffic shall be maintained, and all utilities and other property protected.

Trenches shall be excavated to the depth indicated on the Drawings and in widths sufficient for laying the pipe, bracing and for pumping and drainage facilities. The bottom of the excavations shall be firm and dry and in all respects acceptable to the Engineer. Trench width shall be kept to a practical minimum.

Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of subgrade soils. The trench may be excavated by machinery to, or just below the designated subgrade, provided that material remaining in the bottom of the trench is no more than slightly disturbed. Subgrade soils which become soft or loose, or otherwise unsatisfactory as a result of inadequate excavation, dewatering or other construction methods shall be removed and replaced by screened gravel fill as required by the Engineer at the Contractor's expense.

Clay and organic silt soils are particularly susceptible to disturbance due to construction operations. When excavation is to end in such soils, the Contractor shall use a smooth-edge bucket to excavate the last 0.3meter of depth.

5.8.3 Disposal of Materials

Excavated material shall not be stacked on the trench bank to assure access to residences. Inconvenience to traffic and abutters shall be avoided as much as possible. Excavated material shall be segregated for use in backfilling as specified below.

It is expressly understood that no excavated-material shall be disposed of by the Contractor except as directed by the Engineer. When disposal of surplus materials has been approved by the Engineer, the Contractor shall do so in areas approved by the Engineer and local authorities.

As a matter of general practice, the excavated material shall be hauled and stored at a location provided by the Contractor. When required it shall be re-handled and used in backfilling the trench.

5.8.4 Sheeting and Bracing

Sheeting shall be plumb and securely braced and tied in position. Sheeting and bracing shall be adequate to withstand all pressures to which the structures or trench will be subjected. Any movements or bulging which may occur shall be corrected so as to provide the necessary clearances and dimensions.

Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed. Where soil cannot be properly compacted to fill a void, lean concrete (Class C-150kg/cm²) shall be used as backfill at no additional expense to the Employer.

For purposes of preventing damage to structures, utilities or property whether public or private, leave in place and embed in the backfill all sheeting and bracing as either directed in writing or agreed to by the Engineer. The Engineer may direct that sheeting and bracing be cut off at any specified elevation. Sheeting directed or agreed to by the Engineer to be left-in-place shall be paid for at the unit rates listed in the Bill of Quantities. The Contractor shall not be paid extra costs for sheeting left-in-place to rectify a situation created by the Contractor's own acts or omissions. If after the commencement of excavation, a risk situation develops for reasons not related to construction activities, the Engineer may direct that the sheeting be left-in-place. Such situations may include third party activities or conditions that could not have been reasonably foreseen by a prudent Contractor.

Any instruction in this case will be issued in writing and payment will be made in accordance with the Bill of Quantities. Where in the opinion of the Engineer a risk situation occurs as a result of acts or omissions by the Contractor, no payment will be issued.

Subsequently, if the Contractor chooses to remove the sheeting, he must submit to the Engineer a written recommendation from the designer of the sheeting and bracing system prior to removing the sheeting. The designer shall visit the site, review the structural condition of the adjacent structures and make recommendations for proper removal techniques so as not to endanger the construction, other structures, utilities-or property.

For all cases, authorization for payment for the sheeting left-in-place will be made only if the sheeting is within the "Zone of Influence" of the adjacent structures or utility, the zone of influence will be determined based on existing site conditions and shall be acceptable to the Engineer. In all cases of payment for sheeting left-in-place, the Contractor must obtain written authorization from the Engineer prior to backfilling the trench. Under no circumstances shall payment for sheeting left-in-place be made after the trench has been backfilled.

The right of the Engineer to order sheeting and bracing left in place shall not be construed as creating any obligation on his part to issue such orders, and his failure to exercise his right to do so shall not relieve the Contractor from liability for injury to persons or damage to property occurring from or upon the work occasioned by negligence or otherwise, growing out of a failure on the part of the Contractor to leave in place sufficient sheeting and bracing to prevent any caving or moving of the ground.

All timber sheeting installed to below the spring line of an adjacent pipe shall be cut off and left in place below the level 300 mm above the pipe crown. The cost of this sheeting is construed to be included in the linear meter cost of the pipe.

The Engineer may approve removal of sheeting installed below the pipe spring line if in the opinion of the Engineer, removing this sheeting will have no adverse effect on pipe bedding, subgrade soils or other works.

All sheeting and bracing not left in place shall be carefully removed as the backfilling proceeds in such manner as not to endanger the construction or other structures, utilities, or property. All voids left or caused by withdrawal of sheeting shall be immediately refilled with sand by ramming with tools especially adapted to that purpose, or otherwise as may be directed.

5.8.5 Test Pits

The Contractor may be required to excavate test pits for the purpose of locating underground utilities or structures as an aid in establishing the precise location of new work.

Test pits shall be backfilled as soon as the desired information has been obtained. The backfilled surface shall be maintained in a satisfactory condition for travel until resurfaced as specified.

5.8.6 Excavation below grade and Refill

Whatever the nature of unstable material encountered or the groundwater conditions, trench drainage shall be complete and effective.

If the Contractor excavates below grade through error or for his own convenience, or through failure to properly dewater the trench, or disturbs the subgrade before dewatering is sufficiently complete, he may be directed by the Engineer to excavate below grade as set forth in the following paragraph, in which case the work of excavating below grade and furnishing and placing the refill shall be performed at his own expense.

If the material at the level of trench bottom consists of fine sand, sand and silt or soft earth which may work into the crushed stone bedding notwithstanding effective drainage, the subgrade material shall be removed to the extent directed and the excavation refilled with a 150 mm layer of coarse sand, or a mixture graded from coarse sand to the fine pea stone, as approved by the Engineer, to form a filter layer preserving the voids in the crushed stone bed of the pipe. The composition and gradation of the graded mixture shall be approved by the Engineer prior to placement. The graded mixture shall then be placed in 150 mm. layers thoroughly compacted up to the normal grade of the pipe. If directed by the Engineer, coarse aggregate shall be used for refill of excavation below grade.

5.8.7 Backfilling

As soon as practicable after the pipe has been laid and jointed, backfilling shall begin and thereafter be prosecuted expeditiously. Bedding material as specified for the type of pipe installed, shall be placed up to 0.3 meters over the pipe.

Where the pipes are laid "cross country" or in open fields, the remainder of the trench shall be filled with common fill material in layers not to exceed 0.30 meters and compacted to 95 percent maximum dry density in accordance with ASTM D698 and then mounded 0.15 m above the existing grade or as directed. Where a loam or gravel surface exists prior to cross country excavations, it shall be removed, conserved and replaced to the full original depth as part of the work under the pipe items. In some areas it may be necessary to remove excess material during the clean-up process, so that the ground may be restored to its original level and condition.

Where the pipes are laid in streets, the remainder of the trench up to a depth of 0.3 meters below the bottom of the specified permanent paving shall be backfilled with graded aggregate and thoroughly compacted to 95% density in accordance with ASTM D1557 in 150 mm layers.

The sub base layer for paving shall be select graded aggregate thoroughly compacted to 95% density in accordance with ASTM D1557 in 150 mm layers.

To prevent longitudinal movement of the pipe, dumping backfill material into the trench and then spreading will not be permitted until the specified bedding material for the specific type of pipe has been placed and compacted to a level 0.3 meters over the pipe.

Backfill shall be brought up evenly on all sides. Each layer of backfill material shall be thoroughly compacted by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping, to the required compaction. If rolling is employed, it shall be by use of a suitable roller or tractor, being careful to compact the fill throughout the full width of the trench.

Critical fill areas, as designated on the Drawings or by the Engineer, shall require moisture conditioning so that the moisture content is within 3 percent of the optimum moisture content at the time of compaction. It is the Contractor's responsibility that he obtains his own water for all moisture conditioning operations.

Where other methods are not practicable, compaction shall be by use of hand or pneumatic ramming with tools weighing at least (9) Kg. The material being spread and

compacted in layers not over 150 mm thick. If necessary, sprinkling shall be employed in conjunction with rolling or ramming.

Backfill around pipeline structures shall be select backfill material. All backfill shall be compacted, especially under and over pipes connected to the structures, to 95% maximum dry density in accordance with ASTM D1557 in 150 mm layers.

Broken bituminous paving shall not be placed in backfilling.

All road surfaces shall be hose-cleaned immediately after backfilling. Dust control measures shall be employed at all times.

5.8.8 Restoring Trench Surface

Where the trench occurs adjacent to paved streets, in shoulders, sidewalks, the Contractor shall thoroughly consolidate the backfill and shall maintain the surface as the work progresses. If settlement takes place, he shall immediately deposit additional fill to restore the level of the ground.

In and adjacent to streets, the top 300 mm layer of trench backfill shall consist of compacted select graded aggregate.

The surface of any driveway or any other area which is disturbed by the trench excavation and which is not a part of the paved road shall be restored by the Contractor to a condition at least equal to that existing before work began.

PART -6- As-Built Drawings

The Contractor on substantial completion of the works submits as-built drawings for all works, Contract Drawings should be redrawn by the Contractor, checked by the Engineer and submitted to the Client as-built drawings incorporating all changes and amendments and details required by the Engineer.

The contractor shall keep records of "As-built" drawings throughout the progress of the works, and shall produce a complete set of "As-built" drawings for the whole Contract area.

Regarding to as-built drawings, the contractor should abide by the followings:

- Use pure white permatrace paper thickness 0.07mm (minimum)
 - All drawings must contain the following details:
 - ❖ Cover sheet.
 - ❖ List of drawings, location and key plan.
 - ❖ Site plan (Scale 1/500).
 - ❖ Plot extension (Scale 1/500).
 - ❖ Site works plan including retaining walls (Horizontal Scale 1/500, Vertical Scale 1/100).
 - ❖ Water supply network layout, with all actual distances between fittings, ends of pipes, and distance from sidewalk.
 - ❖ Sewers network layout (Scale 1/500) and profiles (Horizontal Scale 1/1000, Vertical Scale 1/100).
 - ❖ Any drawings required by the client for any works executed in site.
- Regarding to as-built drawings for water, sewer and storm water drainage networks, the contractor should abide by the following and /or as Water Authority requirements:
 - ❖ Plan drawings should be with scale:1/500 and 1/2500.
 - ❖ For profiles use Scale 1/1000 horizontal and 1/100 vertical.
 - ❖ Use pure white permatrace paper thickness 0.07mm.
 - ❖ All plans should be drawn on standard paper size A1 or as required by Water Authority.
 - ❖ All profiles should be drawn on standard paper size A1 or as required by Water Authority.
 - ❖ All sewer profiles must contain:
 - (a) Description of all manholes (cover, diameter) according to water authority specifications.
 - (b) Type and diameter of pipes connecting between manholes.
 - (c) Natural ground (N.G, S.C, WADI, CON., ASP).
 - ❖ In the case of joining of two lines, each line should be labelled by (connected with line ...) at the shared manhole.
 - ❖ The distances that should be drawn on profiles, should start from zero point (EX.MH).

- ❖ When executing of cast in-situ manholes, (C.I.S.) must be written.
- ❖ All profiles and drawings should be prepared, with required accuracy as follows:
 - Original copy on pure white permatrace paper 0.07mm thickness.
 - Sepia copy (one copy).
 - Blue print (three copies).
 - The contractor should provide the client with soft copy, which contains as-built drawings and should obtain the client approval for the type of paper that should be used for original copies.
- ❖ The Engineer's Representative must check all the record drawings before being submitted to the client, also the names of surveyor, contractor's engineer, the engineer's representative and their signatures should be recorded on all drawings.
- ❖ The title of the drawings must be unified in the attached standard drawings.
- ❖ Each house connection station, length and invert level at the plot boundary should be shown on the profiles.
- ❖ No part of the road, which doesn't have a pipeline profile, has to be shown.
- ❖ As built drawings shall not be paid for separately and shall be deemed to be included in the rates of sewers, water and storm water drainage supply executions.

Note

Refere to WAJ General Technical Specification in case of any conflict.

STORM WATER DRAINAGE WORKS

PART (2): EARTHWORKS

General

The Specification for Highway and Bridge Construction issued by Ministry of Public Works and Housing in 1991, section 2.09 (Excavation and Structural Backfill) shall be applied to the earthworks taking into consideration the amendments provided in the following sections.

2.09 Excavations and Structural Backfill

Sub-Section 2.09.4 MEASUREMENT

- Modify Clause No. (4) to read as follows:
 - 4. Structural Excavation shall be measured by cubic meter of material excavated for the major structures, hauled away and disposed of as directed, or stockpiled on or in the vicinity of the Works, and the excavated areas backfilled, completed and accepted.
- Amend Clause No. (6) to read as follows:
 - 6. Sub excavation of unsuitable material, hauled away and disposed of as directed, and backfilling with approved material of the excavated areas shall be measured and paid for as Unclassified Structural Excavation.
- Delete the Pay Items and replace by the following:

<u>Pay Item</u>	<u>Unit of Measurement</u>
(1) Unclassified Structural Excavation (For structural element)	Cubic Meter (cu.m)

PART (5): CONCRETE, STEEL & STRUCTURES

General

The Specification for Highway and Bridge Construction issued by Ministry of Public Works and Housing in 1991, section 5.01 (Concrete and Concrete Mixes and Testing), section 5.03 (Steel Reinforcement and Fixing), section 5.13 (pipe culvers, storm drains, and utility ducts), section 5.14 (drainage and utility structures), section 5.15 (Waterproofing for Structures) shall be applied to all works in PART (5) concrete, steel and structures taking into consideration the amendments provided in the following sections.

Sub-Section 5.01.2 MATERIALS

Add the following to 5.01.2.1:

Unless otherwise noted in the Specification, Drawings or instructed by the Engineer, Ordinary Portland cement shall be used.

Sub-Section 5.01.4 CONCRETE STRENGTH REQUIREMENTS

Add the following:

Unless otherwise shown on the Drawings and Bill of Quantities:

- a) Concrete Class 15 shall be used in all plain concrete, such as mass concrete, blinding etc.

NB. - The minimum cement content should also satisfy the durability requirement as shown on table 5.5 A, table 5.5 B, table 5.5 C and table 5.6 of the General Specifications.

Sub-Section 5.01.8 MEASUREMENT

Add and amend to 5.01.8.2 the following:

Concrete shall be measured for different structural elements as shown in the Bill of Quantities.

Measurement and Payment shall be based upon different classes of concrete as mentioned in Pay Items irrespective of type of form and/or falsework and irrespective of class of surface finish.

Add the following to 5.01.8.4:

- 1) Where Pay Items for any items are not provided in the Bills of Quantities, the works prescribed in respect of such items or the items shown in the drawings shall not be measured for direct payment but shall be considered as subsidiary

works the cost of which shall be deemed to be included in the Contract prices for Pay Items.

- 2) Shear key, induced contraction joints, expansion joints or any other items shown in the drawings shall not be measured for direct payment, but shall be considered as subsidiary to the concrete, the cost of which shall be deemed to be included in the Contract prices for pay items.
- 3) The removal of concrete sections, and the utilization of the existing concrete elements – if any – which involves the exposure of reinforcement to provide the required reinforcement lap length shall not be measured for direct payment, but shall be considered subsidiary to the concrete, the cost of which shall be deemed to be included in the Contract prices for pay items.

SECTION 5.03 STEEL REINFORCEMENT AND FIXING

Sub-Section 5.03.2 MATERIALS

Add and amend as follows:

- 1.1 Reinforcing steel bars shall be deformed bars of high tensile strength, Grade 60, conforming to JSS/441/1986 or AASHTO M31M (ASTM A615M).

SECTION 5.13 PIPE CULVERS, STORM DRAINS, AND UTILITY DUCTS

Sub-Section 5.13.1 SCOPE

Add the following:

1. Reinforced Concrete Pipes (RCP) type shall be used for proposed drainage system as shown on the drawings.
2. Plastic Pipes (PVC) type shall be used for proposed soakaway system as shown on the drawings.

Sub-Section 5.13.4 MEASUREMENT

- Delete Clauses 1 and 2 and replace by:

1. Reinforced Concrete Pipe, shall be measured by lin.m. of each pipe size and type furnished, installed or constructed, backfilled, completed, and accepted.
2. Storm Drains and Utility Ducts shall be measured by lin.m. of each size and type furnished, installed or constructed, backfilled, completed, and

accepted.

- Add the following new clauses:

12. The quantities, measured as provided above, shall be paid for at the contract price per unit of measurement, for the pay items listed below which price and payment shall be full compensation for furnishing and placing all materials including all labour, tools, bents, equipment and incidentals necessary to complete the work described in this section.
13. Pipes connected to Manholes or inlets from either ends shall be measured as storm drain pipes.

- Delete Pay Items and replace by:

	<u>Pay Item</u>	<u>Unit of Measurement</u>
(1)	Storm Drain R.C. Pipe (each diameter and type)	Linear Meter (Lin.m)
(2)	Plastic Pipes (PVC) (each diameter and type)	Linear Meter (Lin.m)

SECTION 5.14 DRAINAGE AND UTILITY STRUCTURES

Sub-Section 5.14.1 SCOPE

- Amend Clause No. (1) to read as follows:

1. This work shall consist of the construction of catch pits, manholes, and curb inlets and similar structures in connection with the drainage from the surface and below the surface of land and paved surfaces.

Sub-Section 5.14.4 MEASUREMENT

- Delete this sub-section and replace by:

1. Manholes, shall be measured by the number manholes constructed, completed and accepted including furnishing and installation of all materials, frames, covers and steps etc.
2. No separate measurement shall be made for any excavation, shoring, sheeting or backfilling, or for breaking into existing pipes in order to install new manholes, all such work being considered subsidiary to the construction of the manholes, and for which no separate payments will be made.

3. No separate measurement shall be made for frames and manhole covers as shown on the Drawings which shall be considered subsidiary to the relevant pay items of manholes.
4. The amount of completed and accepted work, measured as provided for above, will be paid for at the unit prices bid per number for “Manholes”, of various types as specified in the Bill of Quantities, which prices shall be full compensation for all excavation, shoring, sheeting, trimming, blinding and for furnishing and placing all materials, for all labour, backfilling, painting, equipment, forms tools and all other items necessary for the proper completion of the work.

- Replace pay items (1) and (2) by the following:

	<u>Pay Item</u>	<u>Unit of Measurement</u>
(1)	Manhole	Number (No.)
(2)	Inlet (each type)	Number (No.)

MECHANICAL WORKS

1.0 PIPES

1.1 DUCTILE IRON (DI) PIPES AND FITTINGS

1.1.1 Materials

Ductile iron pipes shall conform to the requirements of “Ductile iron pipes, fittings and accessories for pressure pipelines” (ISO 2531 or BS 4772) or other internationally accepted standards which ensure an equal or higher quality than the standard mentioned. All pipe work shall be class K9 unless otherwise stated in the Contract Documents.

DN mm	Wall Thickness mm
400	8.1

1.1.2 Design Conditions Requirements

Each length of pipe shall be designed to withstand the relevant test requirements of ISO. 2531. Hydrostatic pressure tests shall be performed prior to coating or lining of pipes.

1.1.3 Joints

Ductile iron pipes and fittings shall be manufactured with spigot and socket ends in which the seal is achieved by means of a suitable retained rubber gasket (push-on joint). The gasket shall be of such size and shape that, when joined in accordance with the manufacturer's instructions, it shall provide a positive seal within the manufacturer's range of maximum joint deflection and withdrawal under all combinations of joint and gasket dimensional tolerances and in the range of pressure specified.

The joint shall be capable of accommodating the longitudinal movement resulting from a change in temperature of the pipe of 50 degrees Celsius without loss of water tightness.

The manufacturer's allowable joint deflection shall not be more than :

5 degrees up to	DN 300
4 degrees for	DN 400
3 degrees for	DN 500 to DN 600

Where flanged connections are covered by backfill material, then all flanged joints shall be wrapped in Denso Tape or similar approved.

Where connections are in valve chambers then bolts, nuts and washers shall be of stainless steel.

All connecting materials and rubber ring gaskets (steel reinforced) or adaptors shall be provided by the supplier as necessary to connect the valves and any other fittings to the adjoining pipe material, without any additional cost.

“Push-On” joints of any type could be used, that satisfy the pressure as specified in the Tender Documents (test pressure = 1.5 x Nominal pressure) and shall be according to ISO 2531 or equivalent.

1.1.4 Rubber Ring Gaskets

Unless otherwise indicated rubber ring gaskets for pipe installation shall be vulcanized rubber or vulcanized synthetic rubber in accordance with the International Standard ISO 4633. Reclaimed rubber may not be used. Sufficient Lubricant as recommended by the pipe manufacturer shall be provided for pipe installation plus five (5) percent as surplus material costs to be included in the unit rates. Lubricant containers shall be adequate for extended storage and the pipe manufacturer shall supply instructions for storage limitations and environment.

1.1.5 Fittings

Fittings shall be made of ductile iron (ISO 2531) with push-on flexible joints. The pressure class of fittings and special castings shall be class K12 for fittings without branches and K14 for fittings with branches (unless otherwise stated in the contract documents)

1.1.6 Thrust and Thrust Anchors

Bends, tees, tapers, plugs, caps, valves...etc. on ductile iron pipelines or as indicated on drawings shall be well braced against undisturbed soil at the edge of the trench with concrete anchor and thrust blocks. The concrete shall contain 300kgs of cement per cubic meter of concrete and the aggregate well graded and the workmanship shall be in accordance with good practice to the satisfaction of the Engineer. The dimensions and steel reinforcement shall be in accordance with typical sections shown on the detailed drawings or otherwise as directed by the Engineer.

The blocks shall, unless otherwise shown or directed by the engineer, be so placed that the pipe and fitting joints will be accessible for repair.

Where it is not possible to brace against undisturbed soil, suitable fenders shall be arranged as directed by the Engineer.

1.1.7 Pipe Lengths

Pipe lengths shall be 6m in accordance with ISO 2531.

1.1.8 Lining

Ductile iron pipes and fittings shall have a blast furnace cement mortar lining. It shall be applied so that it adheres strongly to the pipe. For pipes the lining shall be as specified in ISO 4179 and shall be applied by a centrifugal process. The lining on

fittings shall also conform with ISO 4179 and shall be applied by a projection method or by hand application with respect to thickness for straight pipes of the same diameter.

The cement mortar lining thickness for pipes and fittings will be in accordance with ISO. 4179. A thickness tolerance of plus 3 mm based on the normal value shall be permitted on pipes and plus 6 mm on fittings.

As an alternative the fittings can be internally protected with a bituminous paint in accordance with (ISO 2531) or with a 150 microns minimum thickness special fusion bonded powder epoxy coating.

1.1.8 External Coating

Ductile iron Pipes (DIP.) shall be provided with standard external coatings for normal soil, ie. Metallic zinc layer, with bituminous paint according to ISO. 8179. Fittings shall be protected with bituminous coating.

When corrosive soils are encountered, Pipes and fittings shall be supplied with polyethylene sleeving of 200 microns minimum thickness according to BS. 6076, DIN. 30674 or ISO. 8180 or approved equivalent standards.

1.1.9 Marking

Each pipe and fitting shall bear the mark of the year of manufacture, nominal diameter, and the word “DUCTILE” on the body of the pipe or fitting. The marks may be cast on, painted or cold stamped.

1.1.10 Testing and Inspection at Place of Manufacture

Inspection for external appearance, shape, dimensions, and weight shall be carried out on each pipe and fitting. Pipes and fittings shall be coated with care to avoid warping. All pipes and fittings shall be sound and free from surface defects.

Each pipe centrifugally cast shall be subjected to the hydrostatic pressure test as specified in ISO 2531. Each fittings and accessory not centrifugally cast shall be subjected to a leak tightness that carried out with water or air as specified in ISO 2531. Any pipe or fitting that leaks or does not withstand the test pressure shall be rejected.

Mechanical tests for hardness, tensile strength, and elongation shall be performed on test pipes selected at random out of castings grouped in lots. Each lot shall be made up of pipes cast successively and shall comprise 200 pipes.

1.2 High Density Polyethylene Pipes and Fittings

1.2.1 General

High Density Polyethylene pipes shall comply with ISO 4427 - 1996 (E) and ISO 161 - 1: 1996

The pipes shall be designed for a nominal working pressure Class of PN 16. Pipes shall be jointed with push-fit coupling, compression fittings, electro-fusion, or mechanical fittings.

Pipes designated as PE 100 shall have maximum allowable hydrostatic design stress of (8) MPa and Minimum Required Strength (MRS) of 10 MPa at 50 years and 20 °C.

The nominal outside diameter and wall thickness for (PE100) pipes are as shown in the following table:

Wall Thickness of Polyethylene Pipes (PE100)

Nominal Outside Diameter (mm)	Wall Thickness (mm)
450	40.9

The length of the coiled pipes shall be 50-100 m or straight lengths, if the pipes are to be coiled this must be done at temperature not less than 30°C. For sizes > 63 mm all coils shall be securely banded with tough tape which cannot be removed except by butting.

The minimum diameter of the rollers for coiled pipe should be such that kinking of the pipe is prevented.

The minimum internal diameter of the rollers shall not be less than 24 times the nominal outside diameter of the pipe with a minimum of 600 mm.

The ends of the pipe shall be plugged or covered.

1.2.2 Materials

The pipes shall be manufacture from polyethylene containing only those antioxidants, UV stabilizers and pigments necessary for the manufacture of potable water pipes and shall be either black or black with blue stripes and comply with (ISO 4427).

The Contractor shall provide an approved third party certificate to verify the above. Materials in contact with or likely to come into contact with potable water shall not constitute a toxic hazard, shall not support microbial growth and shall not give rise to unpleasant taste or odor and cloudiness or discoloration of the water. Concentration of substances, chemicals and biological agents leached from materials in contact with potable water, and measurements of the relevant organoleptic /physical parameters shall not exceed the maximum values recommended by the World Health

Organization (WHO, 1984) or as required by the EEC, Council Directive of 15 July 1980.official Journal of the European Communities L 229 pp.1 1 to 29) on the quality of water intended for human consumption, whichever is the more stringent in each case.

Material of unknown composition shall not be used. Only Polyethylene granules that are approved and listed by International approval bodies (i.e. DVGW Germany / DWI UK or equivalent) shall be used in the manufacturing of PE pipes supplied.

Recycled material generated from a manufacturer's own production of pipes should not be used.

Non-metallic products in contact with or likely to come into contact with potable water shall comply with the requirements of BS 6920. 1996

Carbon black content according to ISO 6964.

The pipe manufacturer shall provide evidence of the nominal values of the density and melt flow rate (index) of the raw material.

The density of the raw material (compound) shall not be less than 0.945 gm/cm³. The pipe manufacture shall provide evidence of the nominal value of the density once at the beginning of the contract upon delivery of material on site, and as instructed by the Engineer.

Density test for raw material and pipes shall be performed according to ISO 1183 or equivalent.

Melt flow rate (MFR) this shall be determined to the method given in ISO 1.133 or equivalent.

MFR shall be less than 1.0 gm/10 min. tested at 190/5 kg, change of (MFR) by processing shall be less than 20%.

1.2.3 Quality

The manufacturer shall operate a quality system conforming to ISO 9001/9002 as applicable.

This shall include a quality plan whereby details and results for each shall be made available to the purchaser or his representative on request. The manufacturer's shall have a written declaration that the polyethylene pipes which they produce for use in public water supplies are manufactured from the granules approved and listed by international approval bodies (i.e. DVGW Germany / DWI UK or equivalent) and that no chemicals or recycled materials are added.

Testing Status

General

Type and batch release tests are carried out by the pipe manufacturer to demonstrate compliance with relevant standard.

a. Type Tests

- Short term hydrostatic strength at 20°C 100 hour according to ISO 1167/1996
- Long term hydrostatic strength at 80°C at 1000 hour according to ISO 1167/1996.
- Long term 80°C stress crack resistance on notched pipe. When tested in accordance with ISO 134/9. Notched pipe test the pipe shall not fail within 1000 hours when pressurized at 9.2 bar (PE 100). This test shall be carried out on SDR 11 pipe.
- Suitability of non-metallic products for use in contact with drinking water intended for Human consumption with regard to the Quality of Water according to BS 6920: 1996.

Hydrostatic Strength

When tested in accordance with ISO 1167, the pipes shall conform to the requirements given in the following table:

Hydrostatic Strength of Pipes (MPa)

Pipe Material	Test Stress 100 Hours at 20°C	Test Stress 165 Hours at 80°C	Test Stress 1000 Hours at 80°C
PE 100	12.4	5.5	5
PE 80	9	4.6	4

For locally manufacture pipes; (regarding 4 tests mentioned above) random samples will be taken from production under a quality assurance system once every 15 months or the requirements shall be met whenever a change or an introduction of a new or modified raw material (compound) has occurred.

For imported pipes; following the delivery of imported pipes to final destination, for each batch delivered, samples will be taken at random to be tested according to BS 6920 dated 1996.

For tests 1, 2, 3 once per size group.

b. Batch Release Test /Factory Testing

Before releasing any batch of pipe, the supplier is required to carry out basic tests specified below:

- Dimensions and appearance ISO 4427 - 1996.
- Thermal stability ISO 4427.
- Tensile properties, elongation - according to ISO 6259 - 1997.
- Melt flow rate ISO 1133 - 1997.
- Short term 80°C stress crack resistance on notched pipe ISO 13479 - 1997

All type and batch release tests shall be conducted by pipe manufacturer and shall be witnessed and verified by third party.

An approved list of accredited third party agencies is issued by Governmental Tenders Directorate Only recognized third party by GTD may be used by manufacturer or contractor.

Third party shall verify that pipes are produced in compliance with ISO 4427.
No pipe shall be accepted unless all type and batch release tests have been passed.

c. Test after Delivery/ Acceptance Tests

Random Samples of PE pipes shall be taken from site as instructed by the Engineer from both locally manufactured and imported pipes for every lot of 10 km of pipes with diameter 50, 63, 75, 90, and 110, and every 5 ton consignment of pipes with a diameter 40, 32, 25, 20, and 16 mm delivered to site.

Raw material samples shall be supplied by the imported pipes manufacturer, especially for carrying out test 2 mentioned below (MFR) The Engineer may instruct in addition to type and batch releases tests to conduct any or all of the following tests on the samples taken from site.

- Dimensions ISO 4427 - 1996 /ISO 161-1.
- Melting flow ISO 1133 - 1997.
- Tensile proper ties, elongation ISO 6259 - 1997.
- Thermal stability ISO/TR 10837.
- Longitudinal reversion test ISO 2505-1994.

d. Test after Delivery/ Acceptance Tests

The pipelines of transmission and water distribution system and all the joints, fittings and appliances shall be tested for water tightness in the field in accordance with CP 312 part 3 (British standard) as follows:

- Allowable leakage < 3 liter/km/25 mm dia. of pipe/3 bar/24 hours.
 - Hydrostatic testing should be carried out at ambient temperature (20°C) otherwise a correction factor (ISO 4427) should be applied to the nominal pressure.
 - Test should be applied on sections of length less than (800 m) with uncovered joints.
1. Partially back filling to maintain adequate support and anchoring and to avoid floating of pipes during testing with joints exposed and valves in the open position.
- Slow fill with water.

- The filling should be at a rate giving a maximum water velocity of (0.5 m/s) in the pipe to insure no surge and to give the air the necessary time to be released by the installed permanent air valves or installing corporation cocks.
- Leave to reach equilibrium, i.e. the same temperature as the pipe and the surrounding soil and to remove all existing air for the saturation of pipe material, if any.
- Apply test pressure (1.5 the max. nominal working pressure at lowest point) slowly to avoid surge and hold for “one hour”. The system should be isolated from the test pump, i.e., no pumping during the one hour test period allowed. Take test pressure to be 24 bars for transmission pipe – lines, distribution system and for service lines including all couplings and fittings in the open position.
- Apply the equation to decide on the success of test mentioned in item (1) above.
- Finally after completing testing, the line should be emptied slowly to prevent shocks or sudden counteraction of pipes.

1.2.3 Marking

All HDPE pipes shall be indelibly marked at maximum intervals of one meter.

The marking shall show at least the following information:

- Manufacture's name and/or trade mark.
- Dimensions (nominal diameter, wall thickness).
- Material, material class (e g PE 100) and pressure class (e g PN 16).
- Production period (date).
- "Water" to indicate that pipes or fittings intended for potable water.
- Serial number
- Batch number

The pipes and fittings (especially the plastic type) shall be rejected, if the above information for marking is not shown clearly on each piece.

1.2.3 Storage and Handling

Polyethylene pipes tubing and fittings should be stored according to the manufacturer's recommendations.

The following general points should be taken into consideration:

- Contact with burrs or sharp mettle edges on racks,.... etc., should be avoided.
- The ends of pipes should be protected from damage to avoid the risk of unsatisfactory jointing.
- The pipes should be stored under cover and protected from direct sunlight including when stocked at the places of delivery.

- Coils may be stored either on edge or stacked flat one on top of the other, but in either case they should not be allowed to come into contact with hot water or steam pipes and should be kept away from hot surfaces. Coils should not be dragged over rough ground to avoid damaging the pipes.
- Storage of pipes in heated areas exceeding 23°C should be avoided.
- If, due to unsatisfactory storage or handling, a pipe is damaged or kicked, the damage portion should be cut out completely.

2.0 VALVES

General

Materials used in valves shall be suitable for potable water.

All valves, on any type of pipeline must be jointed to the pipe by flanges (unless otherwise specified) and shall have a testing pressure of 1.5 times the nominal pressure.

All valves shall be of the non-rising stem type, and shall be capable with standing the specified test pressure without leaking.

The hand wheels of all valves (including those which incorporate gear) shall be arranged for clockwise closing. All hand wheels shall have, in their periphery, the words OPEN and SHUT and appropriately positioned arrows.

When valves have inaccessible positions, extension spindles shall be fitted to suit the situation.

The contractor shall submit a certificate from the manufacturer certifying that all valves have been mill tested and that they have successfully passed the tests prescribed by the relative standard specifications.

2.1 Altitude Valve

Altitude valve shall Control the level of water in reservoir via a slave ball cock in the top of the reservoir. Small-bore piping in an approved non- corrodable material shall connect the ball cock to the underside of a diaphragm in the relay valve, then through a needle cock to strainer block on the inlet side of the valve.

With a fall of water level in the reservoir and opening of the ball cock, the relay valve shall open, allowing a pressure reduction above the main valve diaphragm. This shall cause the main valve to open and allow filling of the reservoir. When the water level in the reservoir reaches top water level, closure of the ball cock shall cause the relay valve to shut. This shall in turn lead to a build up of pressure above the diaphragm and hence closure of the main valve.

The rate of response of opening and closing of the main valve shall be controlled by an adjustable needle valve which shall enable the operation to be executed slowly,

preventing sudden closure likely to cause problems on the pipeline. The main valve shall open fully in response to a fall of 200 mm. or less in the water level of the reservoir.

Details and materials of altitude valve shall otherwise be as specified below. It shall be double-flanged gray or ductile cast iron. Flanges shall be to BS.4504, PN.16. The nominal diameter shall be as shown on the Drawings.

All materials used in the manufacture of the valve shall conform with the following minimum standards:

Body, Cover and Disc	Spheroidal graphite iron to BS.2789
Valve guide, rings etc.:	Gunmetal to BS.1400, Grade, LG2.
Liner:	Bronze, to BS. 2870.
Seating Face:	Gunmetal, Synthetic or other approved material as appropriate
Indicator Rod:	Stainless steel to BS.970 part 4 Grade: 316529.
Actuating Valve Body:	Bronze to BS.2870.
Spindle:	Stainless steel to BS.970 Part 4 Grade: 316529.
Valve Face:	Nylon
Diaphragm and Bellows:	Reinforced synthetic rubber or approved equivalent.
Orifice body and plate:	Bronze to BS.2870.
Strainer:	Cooper wire cloth.
Spring:	Spring steel.

All detail parts not listed shall be in homogenous corrosion resistant material.

2.2 Flexible Couplings and Flange Adaptors

- For connection of the existing to the new pipeline system, flexible couplings shall be installed as indicated on the drawings or as directed by the Engineer.
- Couplings must be capable of adapting to different pipe materials.
- Flexible couplings and flange adaptors shall be of mild steel and of an approved type suitable for making a watertight flexible connection between plain-ended pipes, or between a plain-ended pipe and a flanged fitting (e.g. Viking-Johnson couplings as manufactured by the Victualic Co. Ltd. Or Dresser Couplings as manufactured by the Dresser Manufacturing Division in the U.S.A.' or equivalent approved by the Engineer.
- Unless otherwise specified, the external and internal surfaces of couplings and adaptors shall be cleaned down to a metallic finish, then primed and painted with epoxy resin paint, applied by an electro static process.
- All mechanical couplings shall be of appropriate internal diameter and shall be capable of withstanding the maximum working test pressure specified for the pipes they are to connect, including a joint deflection of up to 3 degrees in any direction.

- All mechanical couplings and flange adaptors shall be supplied complete with all necessary coupling rings, nuts, bolts, washers and rubber rings. Wedge joint rings shall comply with BS. 2494, and shall be made of nitrile rubber, ethylene propylene rubber (EPDM) or styrene butadiene rubber (SBR) or other approved materials.
- Bolts and nuts of galvanized steel shall be hexagonal with dimensions in accordance with BS. 4190 or DIN. 601/555.
- Where a Harnessed Steel Flange Adaptor is shown on the drawings, the bolts connecting the flange of the Flexible Flange Adaptor to the Flange of the adjacent fitting shall be replaced by tie-bars threaded at both ends.
- One threaded end of each tie bar shall pass through holes in the abutting flanges and be anchored by two nuts to make the flanged joints in the normal way. The other threaded end shall be anchored by two further nuts in a corresponding bolt-hole on the flange, soundly welded integrally on to the fitting which it is intended to harness to the adaptor.
- The integrally-cast flange on the flange-spigot shall be located such that, after the joint has been made and all nuts fully tightened, the integrally-cast flange is about 400 mm axially from the abutting flanges.
- The bolt circles on all the flanges shall comply with BS 4504 PN 16, as specified.
- The threaded tie bars shall be machined from steel at least equal to that specified for flange bolts of corresponding duty and threaded in the same way. The threaded length shall allow the nuts to be run forward sufficiently to permit complete withdrawal of the tie bars from the flange of the abutting fitting without requiring any other joint to be dismantled.
- The strength of the threaded tie-bars in both tension and compression shall be appropriate to the pressure rating of the flanged joints.

3.0 SUBMERSIBLE PUMP

A. Mechanical Part

Submersible pump shall be of the centrifugal multistage type utilizing standard production parts and shall be well proven in design, quality of manufacturer and operational reliability.

Pump stage casing shall be of cast iron or cast steel withstanding the pressure and stresses specified in the bill of quantities, stainless steel is also accepted.

Renewable bronze wear rings have to be fitted to the stage casings to maintain good efficiency while operation in different water quality conditions - offers for pumps not provided with these wear-rings will not be accepted, renewable stainless steel wear rings are also accepted.

Pump impellers shall be casted from high grade bronze, where applicable balance holes shall be provided in the impeller hub to reduce imposed axial thrust; stainless steel impellers are also accepted.

Pump shaft and the coupling shall be made of high tensile stainless steel of a diameter sufficient to prevent distortion from the stresses imposed on them. Critical shaft speed shall be above maximum running speed. The shaft main guide bearing located in the suction and delivery housing of the pump shall utilize bronze material, and shall be provided with protection guards to prevent ingress of sand and incrustations (up to 25 g/m³).

Pump stage casing guide bearing shall be of approved abrasion-resistant materials. All bearings shall be lubricated by the water to be pumped. The pump delivery and housing shall incorporate a thrust washer of suitable material at the shaft end to absorb up-thrust that occur during pump starting.

The pump shall incorporate a delivery check valve (non-return valve).

The pump shall be provided with screwed connection (no flange connection) at the delivery housing (thread of riser pipes API-SL).

A stainless steel strainer shall be provided on the pump suction housing (no synthetic material will be accepted).

The efficiency of the pump shall not be less than 73%. The required submersible pump shall be of 90 m³/hr flow and 4 bar head to pump water from proposed irrigation tank through proposed irrigation network.

Material Specifications

• Stage casings	cast iron
• Renewable wear-rings	Bronze
• Impellers	Bronze

• Pump shaft and coupling	stainless steel, 1.4301 or higher
• Shaft guide bearings	Bronze
• Suction strainer	stainless steel, 1.4301 or higher

Submersible Motor

The diameter of the motors shall be selected also in view to the Dia. of the borehole casing diameters given in the bill of quantities .

The Submersible Motor shall be "wet" squirrel cage induction type designed to operate continuously under submerged conditions and shall comply with the requirements of the IEC Publications 34 and shall be rewindable.

The motors have to be designed to the following specifications:

Water temperature 50°C shall be rated at least 15% above the maximum required power of the pump, have to be selected for starting with auto-transformers - reduced voltage throughout the starting sequence (tapping about 70%), the winding shall be insulated with an approved heat resistant material (e.g. PVC) of high insulation (class y recommended), four starts in one hour when the motor is cold or hot, shall be provided with a heavy duty multipad thrust bearing at the base of the motor to absorb the shaft down-thrust developed by the pump.

The bearing design shall incorporate tilting thrust pads of stainless steel arrange to self adjustment according to thrust load. The thrust disc shall be of a suitable carbon based or similar approved material, has to be filled with cooling liquid (if additives are used, a certificate for drinking water application has to be added), a sand guard and mechanical seal to protect the motor, all motors have to be equipped with thermal protections (3-wire PT-100 system) thermally contacted to the windings at the upper part of the motor. (Offers only with 3-wire PT-100 system are accepted).

The motor shall be equipped with the whole length from motors to the switch-gear double insulated marine cables ,which are allowed to be used in drinking water , with tinned annealed copper conductors. The cable alongside the pump casing shall be covered with a stainless steel plate screwed on the pump stage casings.

The diaphragm cover located at the end of the motor has to be made of cast iron or steel (no synthetic material will be accepted).

The cooling velocity of. provided the velocity is lower than 0.5 m/s - upstream the motors have to be delivered with shrouds.

B. Material Specifications

• Motor Shaft	stainless steel, 1.4301 or higher
• Motor Housing	stainless steel, 1.4301 or higher
• Motor Guide Bearing	Bronze
• Bolts, Nuts, Studs, Screws, Washers etc.	stainless steel
• diaphragm cover	cast iron or steel

C. Riser pipes

Between riser pipe and pump a stainless steel adapter shall be connected.

The riser pipes shall be in accordance with API-5L, GRADE-B line pipe. The pipe shall be seamless or seam welded by ERW and shall be threaded from both sides according to API-5L, 8 threads per inch.

(ND) Diameter (mm)	Thickness (mm)	Test Pressure (Kg/cm ²)
100	6.0	89
150	7.1	89

The working pressure for the pipes shall not be less than 50 bars.

D. Pipe Joint and Jointing

The pipes shall be threaded from both sides 8 threads per inch according to API-5L. Each pipe shall be provided with coupling. Long type coupling 20-25 cm. Threaded from inside must be according to API-5L; and provided with the other end with protector to prevent damage of thread.

The pipes and couplers when jointed together must be aligned through the depth of the pump, which reach to 300m, and shall not have deflection through this distance.

The threading for both pipes and couplings shall be done by the manufacturer of the pipes and shall not have any failure during manual or machine threading. The pipes and coupling must be suitable to be used with submersible pump in which depth reaches 300m, so it must be strong enough to carry the pump set, the weight of the pipes and the water column to withstand the vibration of the pump set and the pressure of the water when the valves shut during the operation of the pump set.

Coupling must be all screwed to the end of threading and ready to be installed.

The surface protection is either hot dip galvanized after sand blasting or polyethylene coating.

The pipes shall be marked with the manufacture's symbol or mark plus the code number of standard specification and inspector stamp.

The bidder should provide the following data in his bid

	Description	Data
	Standard of pipe	
	Standard of threading	
	Standard of coupling	
	Length of pipe	

	Length of threading	
	Length of coupling	
	Thickness of pipes	
	Thickness of coupling	
	Test pressure of pipe	
	Type of manual of pipe seamless seam welded	

3.1 Execution

3.1.1 Installation

- A. Installation shall be in strict accordance-with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be set by the Contractor in accordance with the manufacturer's recommendations.
- B. Supply all anchor bolts, temporary lift equipment, power, water, labor, and all other incidentals required for the proper installation of the pumps.

3.1.2 Inspection and Testing

- A. The equipment manufacturer shall furnish the services of a competent and experienced technical representative who has complete knowledge of proper operation and maintenance of the equipment for a period of not less than six (6) days in two separate visits to inspect the installed equipment, supervise the initial test run, and to provide instructions to the plant personnel at the pump station. The first visit will be for checking and inspecting the equipment after it is installed. The second visit will be to operate and supervise the initial field test. At least two of the six days shall be allocated solely to the instruction of plant personnel in operation and maintenance of the equipment at pump stations. This instruction period shall be scheduled at least ten days in advance with the Owner and shall take place prior to plant start-up and acceptance by the Owner. The final copies of operation and maintenance manuals specified in Part I, must have been delivered to the Engineer prior to scheduling the instruction period with the Owner. These services may be combined with those provided.
- B. After all pumps have been completely installed, and working under the direction of the manufacturer, conduct in the presence of the Engineer, such tests as are necessary to indicate that pump efficiency and discharge conform to the Specifications. Each pump shall be hydrostatically tested at the shop. Field tests shall include all pumps included under this Section. Supply all electric power, water or wastewater, labor, equipment, and incidentals required to complete the field test.

- C. If the pump performance does not meet the Specifications corrective measures shall be taken by the Contractor, or pumps shall be removed and replaced with pumps which satisfy the conditions specified. A 24 hour operating period of the pumps will be required before acceptance. During this 24 hour operating period, the Contractor shall supply all necessary power and water.
- D. The components of each lubricating system shall be completely tested by the Contractor in the presence of the Engineer. Any component parts which are damaged as a result of testing or which fail to meet the requirements of the Specification shall be replaced, reinstalled and retested at the manufacturer's expense.
- E. The pumps and motors shall be designed and constructed to avoid the generation of objectionable heat, noise, or vibration. The sound pressure level at full load shall not exceed 90 (A Scale) decibels above 300 cycles, when measured at a point not exceeding 1.5 meters from the motor. Mufflers or external baffles will not be accepted. When operating at any point between no-load and full-load, the vibration measured in a horizontal plane above the pump and motor shall not exceed the limits recommended by the Hydraulic Institute Standards.

4.0 Measurements and Payments

1. Measurement for payment of supply and install HDPE pipe.

Unit of Measure: Length meter.

2. Measurement for payment of supply and install DI pipe.

Unit of Measure: Length meter.

3. Measurement for payment of supply and install submersible pump, of 300m³/hr and head of 1 bar, will be made by number of the pumps supplied and installed. The price shall include all necessary civil works, fittings and all necessary works as per specifications, drawings and instructions of the Engineer. The cost of the supply and install the pump shall be included in the rate as tendered in the priced Bills of Quantities.

Unit of Measure: Number.