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## **SECTION – 1**

### **GENERAL**

- 1.1** This General Specification is to be taken as applying to all the works in this Contract unless otherwise specifically mentioned elsewhere. Figured dimensions on the working drawings shall be followed in preference to the scale.
- 1.2** Until and unless specified otherwise, all goods and materials are to be Pakistan manufactured and to be of the best quality new and un-used and where not otherwise specified shall be according to latest engineering practice and conforming to Pakistan Standards (PS) or British Standard Specifications (BSS) or Standard of American Society of Testing Materials (ASTM). The Engineer or the Consultants may also supplement such specifications during the progress of work based on standard International Practice.
- 1.3** All materials and goods used for such and other items shall be subjected to standard testing and if found below the specified standard such as PS or BSS or ASTM or their equivalent shall be removed from the LARKANA immediately at Contractor's own expense. All testing of materials finished and unfinished, shall be carried out by the Contractor at his cost, in the presence of Engineer or Engineer's Representative for which the Contractor shall make any other additional arrangement to the satisfaction and convenience of the Engineer. The Contractor shall include testing charges in his quotations and shall not be entitled to any reimbursement on this account.
- 1.4** The Contractor must give early attention to the submission of samples of materials for approval of the Engineer, indicating the names of the manufacturing firms, especially of pipes, fittings, valves, meters, cement, source of sand, aggregates, steel, and all fittings to be embedded. Whenever required samples shall be submitted at least three weeks before it is proposed to use the materials. Until and unless specified otherwise, whenever materials are ordered to be forwarded to a testing laboratory approved by the Engineer for checking / testing, the Contractor will bear the cost of fees for such tests. The Contractor shall indicate the name and address of factory from where he intends to get pipes manufactured and submits manufacturer's catalogues for valves, fittings, and water meters with his tender.
- 1.5** The Contractor must take all steps necessary to prevent damage or interference with all services such as road, water, electric power, fuel, telephones, drains, buried cables and any construction designed for the use of the public, government or semi government authorities or the Employer. The Contractor shall be responsible for any damage caused to such services or constructions and settle and make payment for all claims in respect of such damage.
- 1.6** The Contractor shall protect from damage or injury by covering all work, internally and externally needing protection including new concrete, block work / stone work, surface renderings, floors, etc., to the satisfaction of the Engineer.
- 1.7** The whole work shall be carried out in the best manner in accordance with the instructions contained in these documents and those given by the Engineer from time to time during the progress of the work. The work shall be carried out in conformity with the best standard construction practices preferably the British Codes of Practices.
- 1.8** The Contractor shall submit to the Engineer for his approval before beginning the work, a complete plan of the proposed sequence and methods of operations for the execution of the works.
- 1.9** Orders and directions may be given orally by the Engineer or his Representative, and shall be received and promptly obeyed by the Contractor or his Representative or any superintendent or foreman or any supervisor of the Contractor who so ever may have charge of the particular part or section of work in relation to which the orders or directions are given, and a confirmation in writing of such order or directions will be given to the Contractor by the Engineer within seven days. The Contractor shall provide and maintain at his own expense, during the performance of

the work, an office in the vicinity of work, where he or his authorized representative shall be present at all times. Orders or directions, written or oral, from the Engineer or his Representative delivered at such office shall be considered as delivered to the Contractor.

- 1.10** The Contractor shall construct suitable office for Consultants and Client staff. This office shall comprise of a room of size 5m x 4m with attached wash room and provided with suitable furniture. The Contractor shall provide maintenance service for Consultants office including lighting and water for wash room and daily cleaning. The Contractor shall submit a detail drawing of office along with list of furniture and fitting in his tender.

**1.11 PAYMENT**

Contractor shall not be entitled to any separate or additional payment on account of these entire general requirements and any other arrangement or action unless otherwise provide in the BOQ Contractor has to undertake, under the direction of the Engineer, for a proper carrying out of the works and meeting all obligations of the Contract.

**2. INTERPRETATION**

- 2.1 The clause headings in these specifications shall not be deemed to be part thereof or to be taken into consideration in the interpretation or construction thereof or of the Contract.
- 2.2 Any clauses in these specifications, which relate to works or materials not required, shall be deemed not to apply.
- 2.3 Where this general specification contains any amendments, implications, etc to subsequent sections of the specifications, the General Specification shall be deemed to apply in cases of conflict.

**3. AUTHORITY'S LETTERS**

The Authority referred to in this specification shall be Larkana area unless specified otherwise.

**4. LOCATION AND ACCESS**

As per related plans and drawings in Volume III of Tender Documents.

**5. LEVELS AND REFERENCE POINTS**

The levels shown on the drawings are related to survey of Pakistan. The contractor shall set out the works and shall be responsible for true and perfect setting out of the same and for correctness of the direction, levels, and dimensions and for the alignment of all the components of the works. If at any time any error in this respect shall appear during the progress of work, the contractor shall at his own expense, rectify the error to the satisfaction of the Engineer or his representative(s). The contractor shall construct accurate benchmark so that the Engineer's representative can easily check the lines and levels.

**6. DRAWINGS**

These specifications shall be read in conjunction with the drawings given in volume III of the tender documents. In case of errors or mistakes or any thing missing if required so shall be as decided by the Engineer.

Before proceeding to make preparation for fabrication, execution, and erection of any fittings and other details of any temporary or permanent works scaffolding, railings, shuttering, doors and windows, iron monger works etc, the Contractor shall be under obligation to prepare and submit all detailed shop drawings for the approval of the Engineer before doing any or all of that described above or directed. Larkana shall have the right to require the Contractor to make any change in the design, which may be necessary in the opinion of the Engineer to make the material or equipment conform to the requirement and intent of these specifications without any additional cost. Approval of Contractor's drawings shall not relieve from any part of his obligation to meet all the requirement of the specification or correctness of their drawings.

**7. MATERIAL'S MAKE, STANDARDS AND REGULATIONS**

- 7.1 Until and unless specified otherwise, all goods and materials are to be Pakistan manufactured and to be of the best quality.
- 7.2 All reference to standards throughout these specifications shall be deemed to refer the latest current edition at the date of tender, unless a particular edition has been referred to in the Specification.
- 7.3 All materials and equipment shall comply with the appropriate standard published by the British Standard Institution, Pakistan Standard Institution, and American Society of Testing Materials or with an acceptable International Standard. The Engineer may also supplement such specification during the progress of work based on Standard International Practice.
- 7.4 Alternative International Standards will only be acceptable if found equal to or better than the relevant British or Pakistan or American Standard. Two copies of each alternative standard, all in English, must accompany any request by the Contractor for approval of alternative International Standards.

**8. UNITS OF MEASUREMENTS**

- 8.1 The units shown in these specifications are in MKS. Units unless specified otherwise.
- 8.2 All gauges and instruments shall be calibrated in S.I. Units unless specified otherwise. Equipment and pipe work shall be designed in MKS. Units unless as decided by the Engineer.

**9. WATER, ELECTRICITY SUPPLY, GAS AND OTHER UTILITIES**

- 9.1 The contractor shall make his own arrangements with regard to the supply of water and electricity as required by him for the purpose of construction of water supply and sewerage system and drainage and other construction works for Larkana. The Contractor shall apply for water connection direct to concerned authorities of Karachi and it shall be his responsibility to obtain water connection from and pay water charges directly to authority under their prevailing terms and conditions. At the end of contract period, the Contractor shall arrange at his own risk and costs and shall furnish NO DUES CERTIFICATE (s) at the time of his final bills failing which the amount due shall be ascertained at his risks and costs by the Engineer and liable to be recovered from any money due to be paid to the Contractor. For electricity use for the Contractor's offices and during construction, the Contractor shall make his own arrangements and furnish NO DUES CERTIFICATE(s) from concerned authorities at the time of his final bills failing which the Engineer shall take necessary action as detailed above in respect of water supply dues. Similar procedure shall be adopted in case(s) of Gas Supply and other utilities.

**10. PROGRESS REPORTING**

On or about the first working day of every month, the Contractor shall furnish Six Copies of Monthly Progress Report along with Photographs to the Engineer with the following information:

Activities completed since the last report on the Performa as prescribed by the Engineer. The progress report in general shall contain changes in Contract programmed if any, Parts of the work ready to be tested, inspected or commissioned prior to hand over.

**11. ACCESS ROADS, FOOT PATHS ETC**

The Contractor shall provide & maintain reasonable & safe access to the Larkana, vehicular accesses to commercial and residential properties, footpaths etc. affected by the work in progress under the Contract. All such access shall be kept clear of Contractor's construction materials, machinery, equipment tools and plants as well as any debris to provide complete 'right of way' to the public, pedestrians and vehicles including vehicles of supervisory staff engaged on work at the Larkana.

**12. DEMOLITION AND DISMANTLING OF THE EXISTING WORKS**

The Contractor shall obtain the prior approval of the Engineer before proceeding with demolition of existing works like sewer, manholes and culverts etc.

**13. CONSTRUCTION OF NEW CONCRETE STRUCTURES**

The Contractor shall submit his proposals including drawings showing formwork arrangement and position of construction joints to the Engineer for approval at least 7 days before execution.

**14. FLOATATION**

The contractor is reminded that, fulfilling his obligations as to the care of the works in accordance with clause - 20 of the conditions of contract, Vol-I . He shall take all necessary precautions against floatation of structures and pipe works.

**15. WORKS IN THE VICINITY OF RAILWAYS, HIGHWAYS, WATER COURSES AND OTHER EXISTING STRUCTURES AND SERVICE LINES**

Any works crossing or having effect on railway property public highway watercourse and other existing structures shall be subject to the approval of the Engineer and the concerned competent authority.

**16. PROGRAM**

The Contractor shall submit along with his tender, his construction program, arrangement for dewatering, details of side supports for Concrete structure and trenches and Method Statement of Construction along with proposed sequence and methods of Operation for the execution of work.

**17. TESTS**

17.1 All materials and goods used for such and other items shall be subject to standard testing methods. If any item found below the specified standard shall be replaced immediately at Contractor's own expenses.

17.2 All reasonable facilities and assistance including access to drawings and production data shall be furnished when needed during the inspection at Contractor's or manufacturer's works or anywhere.

17.3 All testing of material items in finished or unfinished state if required shall be carried out by the Contractor at his cost in the presence of Engineer's Representative(s) for which the Contractor shall make all additional arrangements to the satisfaction and convenience of the Engineer. The Contractor shall construct a reasonably equipped laboratory at site area of work as instructed by the Engineer. The Contractor shall provide all machinery equipment, supply of Chemical, operate and maintain the laboratory besides employing competent and efficient staff up to the satisfaction of the Engineer to facilitate timely testing to expedite the progress of the works under Contract. The Contractor shall include testing charges in his tendered rates and shall not be entitled to any reimbursement on this account for testing other than permitted so.

17.4 The Contractor is required to submit the samples of materials required by the Engineer for approval. The Contractor shall indicate the name of manufacturing firm of cement, steel, pumping machinery, pipes, valves, fittings and sources of aggregates etc to be used. Whenever required the samples shall be submitted at least three weeks before materials are proposed to be used. Until and unless specified otherwise whenever materials are ordered to be forwarded to a testing laboratory approved by the Engineer for check and testing. The Contractor will bear all cost for transport, lodging, boarding and reasonable daily expenses on visit by Engineer and his Representative(s) for inspection any goods materials, machinery, pipes, etc at the place or country of manufacture. The Contractor shall quote separate unit rates for each of the aforesaid items in the BOQ of the particular Contract of work under the project at the time of tendering without fail.

Sampling for testing of materials at site shall be carried out as per standard sampling procedure to the satisfaction of the Engineer or his representative(s).

**18. TEST CERTIFICATES**

- 18.1 When tests are carried out up to the approved appropriate standard the Contractor shall furnish to the Engineer such Test Certificate (in quadruplicate).
- 18.2 The Certificates shall display inter alia the date of each test location of each test and the results of each test together with the applicable limits defined in the standard. The certificates shall indicate as to whether in the manufacturer's opinion, the items have passed the test(s) satisfactorily or not. However the Engineer's or his representative's decision shall be final.
- 18.3 For Test which the Engineer or his representative(s) copies of the test records duly signed by the manufacture and the Engineer have witnessed or their representatives shall be appended to the test certificate.

**19. FILL****i) Fill – Granular**

- Granular fill material shall comprise well graded gravel or crushed rock and lie with in the following grading limits.

<b>BS SIEVE SIZE</b>	<b>PERCENTAGE PASSING BY WEIGHT</b>
75 mm	100
37.5mm	85 - 100
10mm	45 - 100
5mm	25 - 85
600 microns	8 - 45
75 microns	0 - 10

- The particle size shall be determined in accordance with the requirements of BS 812: Part 103 and BS 1377.
- The material passing the BS Sieve size 250 microns, when tested in Accordance with BS 1377 shall be non-plastic.

**ii) Fill Selected**

Selected fill shall comprise uniform, readily compactable material free from organic materials tree roots, vegetable matter, salts, building rubbish and excluding clay lumps retained on a 75 mm sieve, stones retained on a 25 mm sieve, and shall be selected from the excavated material. Where the Engineer orders material to be obtained from other sources such material will be classed as imported selected fill.

**20. GROUT**

- i) Cement grout shall be made from either ordinary or sulphate resistant Portland cement as used for the structures with the minimum amount of water added to give the required degree of fluidity.
- ii) No sand or other materials shall be added except for grouting in holding-down bolts, etc when sufficient sand, graded in accordance with Table 1 of BS 1200, and an approved water reducing mixture complying with BS 5075: Part 1, to reduce shrinkage.

**21. JOINT SEALING COMPOUNDS AND SEALANTS**

- i) Joint sealing materials shall be of approved manufacture and supplies delivered fresh with adequate shelf life to meet contract requirements.
- ii) Joint sealing compounds shall be impermeable ductile materials of a type suitable for the conditions of exposure in which they are to be placed, capable of providing a durable, flexible and watertight seal by adhesion to the concrete throughout the range of joint movement.
- iii) All poured joint sealants shall comply with BS 2499, ordinary Type A-1 sealant.
- iv) Cold poured polymer-based joint sealants shall comply with BS 5212, Normal Type N Sealant.

- v) Two-part polysulphide-based sealants shall comply with the relevant provisions of BS 4254. Pouring Grade shall be applied to horizontal upward-facing and Gun Grade to joints of any other aspect or inclination. Other two-part polymer-based sealants of Gun or Trowel Grade shall comply with the physical and test requirements of BS 4254.
- vi) Silicon based building Sealants shall comply with the relevant provisions of BS 5889.
- vii) Polyurethane-based sealants shall comply with a specification of an approved manufacturer.
- viii) Primers for use with joint sealants shall be compatible with, and obtained from the same manufacturer as, the adjacent sealant. Primers shall have no harmful effects on concrete.
- ix) Sealants and primers, which will be in contact with water to be used for potable supply, shall not impart to water taste, color, or any effect known to be harmful to health and shall be resistant to bacterial growth.
- x) Sealants and primers, which will be in contact with sewage or sewage sludge, shall be resistant to biodegradation.

## **22. JOINT FILLER-PERFORMED**

- i) The material comprising the joint filler shall be of such quality that it can be satisfactorily installed in position at the joint.
- ii) Adhesives used to retain performed joint fillers in place during construction shall have no harmful effects on concrete, and, except for those used in connection with softwood fillers, shall be obtained from the same manufacturer as the joint filler.
- iii) Performed filler for joints in structures to retain aqueous liquids shall consist to cork granules, bound together with bitumen or synthetic resin.

## **23. CEMENT MORTAR**

- i) Cement for mortar shall be ordinary Portland Cement except for sub structure, brickwork in manholes, chambers, pond division walls, substructures etc, where Sulphate Resisting Cement shall be used or except otherwise specified. Sand for mortar shall be as described in BS 1200 Table-1.
- ii) Coloring agents and plasticizers shall not be used without the approval of the Engineer.
- iii) Cement mortar to be used for plaster and masonry work shall be 1:4 or as specified.

## **24. PIPES AND FITTINGS uPVC PIPES.**

uPVC pipes for sewer / water supply manufactured from approved pipe factory .The pipe shall confirm in all respect to BS 3505 and PS 3051:1991. The uPVC pipe jointing shall be cement solvent joint or Z-joint. All uPVC fittings shall be used to match the uPVC pipe as per manufacturer detail.

The contractor shall provide the technical detail and brouchers to the Engineer or Engineer's representative for approval.

## **25. SHORT PIPE LENGTHS**

- (i) Short pipes shall be supplied in specific lengths according to pipe diameter and as detailed on the Drawings and in the Bill of Quantities.
- (ii) Additional random short lengths of PVC lined concrete pipes of diameter less than 600mm will be necessary for completion of pipeline gaps between manholes where no cutting of pipes is permitted under normal circumstances.

## **26. ROAD MATERIALS**

- (i) The aggregate for base course and wearing course shall consist of clean durable crushed rock complying with the quality requirements of BS 4987 "Bitumen Macadam with Crushed Rock or Slag Aggregate".
- (ii) Filler shall consist of crushed rocks, or other material approved by the Engineer, and least 75% of it

shall pass a No. 200 BS Sieve. Filler shall be used, if required for compliance with the grading limit for aggregates in base or wearing courses or for surface application.

- (iii) Bitumen for surfacing shall be of grade 80 / 100 penetration (BS 3690 Part (1) and shall have a known specific gravity and a known temperature / viscosity relation.
- (iv) Bitumen for prime coat to base shall be of mix on (MC-0) or similar approved cut back bitumen.
- (v) Bitumen for tack coat to existing carriage ways prior to resurfacing shall be of Mix Composition (MC-1) or similar approved cut back bitumen.

**27. SAND FOR MORTAR, RENDERING AND SCREEDS:**

- (i) Sand shall pass a 5mm (3 / 16") sieve and consist of disintegrated rock or crushed hard stone or gravel or a combination of these, graded in accordance with BS 1200 Table - 1, as follows:

BS SIEVE	% BY WEIGHT PASSING SIEVE.
5MM	100
No. 7	90-100
No. 14	70-100
No. 25	40-80
No. 52	5-40
No.100	0-10

- (ii) Sands shall be washed and free from impurities such as sulphates and organic material incompatible with cement; clay or oil that reduce bonding qualities; material that will expand or shrink; organic matter that can decompose salts and substances that attract moisture; minerals that can cause staining of mortar.
- (iii) Sands shall be tested regularly in accordance with BS: 812 part 103 to give a continuing proof of suitability. The presence of fine clay, silt and dust shall be limited to 5% by weight.

**28. DAMP PROOF COURSE**

DPC where required shall be provided are to be used as per direction of Engineer in accordance with the following specifications:

- i. Damp Proof Courses shall be of hessian based bituminous sheeting weighing 4.3 kg per sq.m and conform to BS 743. The damp proof course shall be of the proper width to suit the walls.
- ii. Damp Proof Course of cement concrete class C (1:2:4) of 2 Inches (50 mm) thickness shall be laid on walls at plinth or at location shown in drawing. Pudlo or other waterproofing agent as approved by Engineer shall be mixed with concrete as per the manufacturers direction and approved by the Engineer. The size of the coarse aggregate shall be limited to 3 / 4" to 3 / 16" (19mm to 4.8mm). the damp proof course shall be of proper width to suit the wall.

**29. MANHOLE COVER**

- i. Mild steel frame and R.C.C. cover shall be made as per drawings.
- ii. Cover shall be fitted to matching frames and tested at the manufacturer's working. Each set (cover and frame) shall be similarly numbered in a legible and permanent manner. The marked position is not to be visible when fitted in place.
- iii. The Contractor shall ensure that the covers are fitted to the appropriately numbered frames after the frames have been fitted.
- iv. Covers shall have the letters KSEZ clearly casted in the upper side of the covers in letters approximately 3 inches (75 mm )high.
- v. Covers shall be lockable to the frame by means of a inside catch which is key operated.

**30. PAINTS**

- i. The Engineer shall approve all brands of paint, under coat and other finishing material. Different brands of paint shall not be intermixed or interchanged on any surface.

- ii. All coating materials shall be supplied in container not greater than 5 liters capacity and labeled with the type of material manufacturer's batch number, date of manufacture and manufacturer's name brand name, formula and shall be mixed and applied in accordance with directions of the manufacturer.
- iii. Batch deliveries of coating material shall be dated for use in order of delivery, shall be stored in a dry area, protected from extreme temperature and shall not be used if more than 18 months old from date of manufacture.
- iv. All material shall be acceptable, proven top grade products and shall meet or exceed the minimum standards of reputable manufacturer as approved by the Engineer.
- v. Colors shall be pure, non-fading pigments mildew-proof, finely ground in approved medium. Colors used on plaster and concrete surfaces shall be lime proof. All materials shall be subject to Engineer's approval.
- vi. All emulsion paints and primers for metal work and walls will be the best available of its type. The Engineer prior to its procurement shall be approved the make and shade.
- vii. Approved quality of Cement wash paint shall be used for painting the exteriors of the structures or other surfaces as directed by the Engineer.
- viii. The plastic emulsion paint or similar as approved by the Engineer shall be used for interior surface.
- ix. Unslaked lime, gun and marine blue shall be used for white washing.
- x. All material for bitumen painting shall consist of Bitumen PB-4 Grade 10 / 20. It shall be used for foundation or wherever recommended by the Engineer.
- xi. Approved quality, Epilac enamel paint shall be used for chemicals and water resistance where specified.
- xii. DUROCEM a cement base heavy-duty waterproof coating manufactured approved by the Engineer shall be used for painting on the surface specified. The cement base water proof coating for concrete shall conform to ASTM C-109, C-67, D-822 and G-23 Solvent for cleaning metal work prior to application of metallic lead primers to BS 2523 shall be as recommended by manufacturer.

### **31. WATER PROOFING**

- i) Cement, aggregate and coarse sand shall be in accordance with the Specifications for "Concrete". Bitumen used for this purpose shall be as per B.S.S or P.S.
- ii) Samples of all materials proposed for use under this section shall be submitted to the Engineer for his approval.
- iii) Water Proof Building paper shall be grade B2 as per BS-1521.

### **32. LADDERS - RUNG TYPE**

- i) Steel ladder shall consist of specified size of M.S Plates in strings and 1" (25mm) dia. M.S Steel bars in rungs. The M.S Rungs shall be riveted and welded in 25mm dia. holes in Plates. The end of each climb of the ladder shall be embedded in the concrete.
- ii) Ladder shall be fixed using M 16 stainless steel bolts unless otherwise detailed.
- iii) Ladder shall be of integral or welded construction and shall comply with the requirements of BS 4211 for the spacing of stringers, rungs, safety hoops and hand holds unless otherwise detailed.
- iv) Ladders shall be made of mild steel and be hot dipped galvanized after manufacture.

## SECTION – 2

### EARTHWORKS

#### 2.1 SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all plants, equipments, appliances labour and materials in performing all operations in connection with excavating, filling and backfilling construction works required for laying pipelines, fitting valves and other ancillary works complete in strict accordance with proper gradient, slope with top and bottom of trenches etc. as per Specifications and drawings and subject to the terms and conditions of the Contract.

#### 2.2 EXCAVATION

##### 2.2.1 General

The contractor shall remove the whole of the vegetation, top soil, concrete, flagging, paving, and curbing, road metalling and other materials from the site of any excavation and shall keep separately and preserve the same for re-use where applicable. The ground shall be excavated for the permanent and temporary works to the required depths, width and levels so that the dimensions of the permanent work shall not be less than as shown on the Drawings, or as may be directed.

All rubbish, filth and matter of an offensive nature taken out of any excavation shall be disposed off at once and not left on the surface within the site area.

##### 2.2.2 For Pipelines

- (i) The excavation shall be carried out to the required alignment, levels, slopes or gradients as per drawings or described in the specifications and bill of quantities taking into account bedding required below pipes or to such other dimensions and slopes as the Engineer may direct in writing to facilitate laying of pipes. No trench excavations shall be commenced without prior approval of the Engineer. Excavation shall proceed at the same rate as laying, jointing, testing and backfilling.
- (ii) The quantity of excavation shall be the volume of materials removed from below the original surface of the ground to the limits of excavation specified or shown on the drawings. For soft and unstable soils, the Contractor shall provide all necessary supports including timbering or sheet piling to support the sides of trenches. The cost of supply of all material, plant and labour that may be necessary for Larkana clearance, excavation, over break, timbering, sheet piling, shoring, strutting, refilling, watering and ramming, etc., shall be included in the Contract Rates for excavation. In all cases, the quantity of excavation measured shall be the in- volume of the undisturbed material within allowable limits mentioned in the specification. In case sides or ends of any excavation collapse under self-weight or due to any other reason, the contractor shall at his own cost remove all disturbed material.
- (iii) Where the Contractor has excavated to depths in excess of the requirements, he shall refill and compact the excess excavation with 1:4:8 cement concrete up to the correct level at his own expense. Any excavation done in excess of specified width due to any reason, what so ever shall not be payable.
- (iv) The width of the trench for pipes shall be as per drawing. The depth shall be according to drawing and as per direction of the engineer.
- (v) Additional excavation will be necessary at all pipe joints to facilitate the making of joint and application of sealant Joint. Holes shall be of such dimensions, so as to give clear working space around the joint. The Contractor shall make allowance for the additional excavation required for these joint holes in the price tendered for trench excavation. These shall not be separately measured or paid.
- (vi) The length of the trench shall be measured along the centre line of the trench and the depth shall be measured vertically from original ground levels to the average bed level. No deductions shall

be made for the lengths of Tee, beds etc.

### **2.2.3 Trial / Test Pits**

The Contractor is required to excavate trial pits and trial trenches upto about 5% of the total quantity of excavation specified in the contract at appropriate locations to determine the position of existing conduits, water mains, gas mains, cable ducts and sewers etc. This excavation work shall be done carefully with due precaution, so as not to damage any existing services. The Contractor may be precluded from carrying out any permanent work until this information is obtained and may have to adopt his program in accordance with the information so obtained by the Contractor.

Trial test pits will be required to be dug before or during the execution of work at locations approved by the Engineer for determining the condition of soil, checking the location of utility services water levels etc. The size of individual trial pits may be kept 1.0 x 1.0 meters or as appropriate / approved by the Engineer upto the required depth. The dimensions may be varied depending upon the site condition and as per instruction of the Engineer. The Contractor shall obtain prior permission from Engineer in writing before start of work on trial pits. No separate payment shall be made for trial pits required to be dug by the Contractor.

The cost incurred by the Contractor on the trial / test pits shall be deemed to be included by the Contractor in his rates for excavation.

### **2.2.4 Classification of Soils**

Excavation shall include the removal of all materials in all kinds of soils or stratas of every name and nature. If rock is encountered it shall be removed carefully and without excessive noise and vibration. Blasting shall not be allowable. The quantities of earthwork for category of excavation in rock are provisional. The Engineer shall do the classification of soil during actual excavation. In case the Contractor meets rock during the excavation, the contractor shall request the Engineer in writing for a joint inspection for classification of soil. The Engineer shall visit the site during excavation and give his opinion in writing about classification of soil for the particular site or alignment. The Contractor shall not be paid for the quantities of rock.

The excavation payable shall be limited to the dimensions and elevations as indicated on the drawings.

## **2.3 TIMBERING SHORING & BRACING**

### **2.3.1 General**

The Contractor shall provide where required all shoring, supports etc., to the sides of excavation to prevent sliding or any movement. The timbering, shoring and bracing shall be of adequate strength to withstand the pressure encountered and the Contractor shall be solely responsible for the losses due to collapse or failure of shuttering, bracing, shoring etc. No payment for side support including shoring, shuttering or bracing shall be made. The Contractor's rate for excavation shall be deemed to include the cost of providing and removing side supports timbering, shoring, strutting and bracing with all connected operations.

### **2.3.2 For Pipeline Trenches**

The Contractor shall at all times support effectively the sides of the pipe trenches and other excavation by suitable timbering, bracing, strutting etc. Where required the contractor shall use close timbering in all loose or sandy or unstable stratas if found necessary by the Engineer. It is intended that all timbering and side supports for trenches shall be removed as the work proceeds. The Contractor shall ensure that the removal of timbering and side supports is done gradually and carefully to avoid any damage to existing or new structures, roads, pavements or any other private or public property. All timbering, sheeting and their supports shall be of adequate strength and dimension and fully braced and strutted so that no collapse, subsidence or any damage to public or private property shall take place. The Contractor shall be solely responsible for the sufficiency of all timbering and their supports to be used and all damages to persons or property resulting from

the improper quality, strength, placing, maintaining or removal of the same shall be payable by him under all circumstances.

## **2.4 PUMPING, BAILING AND DEWATERING**

The work covered by this section of Specifications consists of furnishing all plants, labour, materials, equipments and appliances for performing all operations for pumping, bailing, dewatering and draining water from the areas, excavated for trenches and all other works in this contract in accordance with this section of Specifications, and subject to terms and conditions of the contract.

- 2.4.1** The Contractor shall at all times during the progress of work remove any water which may accumulate, inflow or be found in the trenches and other excavations made under the contract, and shall keep them entirely free from water at all times while excavating, providing bedding and laying of pipes.
- 2.4.2** The Contractor shall keep excavations free from water at all time and provide adequate pumping plant including special dewatering equipment and means of disposing off the pumped water. The Contractor shall ensure to keep away un-desired water clear of excavation for permanent works and provide all necessary plant and equipment for dealing with any subsoil condition that may be encountered.
- 2.4.3** The cost of all the works required for pumping and disposal of water from trenches shall not be included in the BOQ rate of excavation, bailing and pumping of subsoil water. Separate payment for dewatering, bailing and pumping will be made to the contractor as per BOQ item.
- 2.4.4** Water pumped from the trenches shall be disposed off by the Contractor in a manner that will neither cause injury to the public health nor damage to the existing structures or the works completed or in progress or to the surface of any roads or streets, nor cause any interference with the use of the same by the public.
- 2.4.5** The Contractor shall be held fully and wholly responsible for all damages done to building and other structures or property resulting from his dewatering, pumping and all other connected operations. If he fails to make good or to pay the expenses of making good damages with all practicable dispatch, the Engineer shall be at liberty to get the work done by other means or to pay the cost of the said damages by deducting the amount from any money that may be or become due to the Contractor or may recover the same from the Contractor from his dues, as decided and found feasible by Engineer, the decision of Engineer will be final.

## **2.5 BACKFILLING AND RESTORING OF GROUND TO ORIGINAL CONDITION**

The back filling of the trench and shall be allowed after the pipe has been laid and jointed over the specified bed, inspected, checked, tested and approved by the Engineer. Filling to depth up to half pipe level shall carry out for backfilling of the trenches. The filling shall then be thoroughly rammed; more filling shall be carried out and rammed again until the consolidated filling reaches pipe top level. Only selected, dry materials free from stones or debris shall be used for backfilling, which shall be spread and rammed evenly across the trench. Thereafter, the trench shall be filled in layers not exceeding 150 mm in depth, each layer being properly rammed before the next layer is placed so that 95% compaction is obtained as per AASHTO Standard.

On completion of backfilling, the Contractor shall level all grounds disturbed by him in the course of the work, spread topsoil where necessary as directed by the Engineer.

## **2.6 REMOVAL OF EXCESS AND UNDESIRABLE MATERIALS**

- 2.6.1** Excess and undesirable material from excavation not required for fill or backfill shall be disposed off, removed and leveled on the site where directed by the Engineer. Earth suitable and meant for backfill shall be stored at site in a manner not to interfere with the progress of construction works in progress.
- 2.6.2** The Contractor shall keep all excavated soil sprinkled with water during the excavation work so as to prevent any dust nuisance.

**2.6.3 Surplus Excavation Debris etc.**

**2.6.4** All surplus soil arising out of the work shall be carried away to approved site, within a week, and spread as directed by the Engineer.

**2.6.5** The Contractor shall carry out the cutting of existing bituminous road as required for excavation for carrying out the work, to the full depth of hard crest of any existing thickness. The stone metal soling etc. shall be separately stacked along the side of excavation for possible reuse.

**2.7 PROTECTION OF UTILITY SERVICES**

**2.7.1 Utility Lines**

When any existing utility line(s) are encountered within the area of operations, the contractor shall take all necessary measures so that these are neither disturbed nor damaged. The Contractor shall be fully and solely responsible for any damage occurring due to non-providing of adequate measures for the protection of such services. The Contractor shall be required to obtain all necessary permissions from concerned departments in writing prior to start of work and maintain the affective liaison for trouble free progress of work(s). The contractor shall pay all fees, charges officially levied by such department while issuing required permission. The Contractor shall furnish originals of payment receipts along with his written request for allowing payments by the Engineer accordingly. In case of restoration to unavoidable damage to any utility service, line or by passing such line the procedure as detailed shall be followed in accordance with rules, regulation, specification or practice as preferred by the concerned department.

**2.7.2 Damage to Surface**

If carriage ways, verges or footways in roads, whether paved or unpaved, or gardens, plantations or other surfaces are damaged outside the limits of the excavations due to lack of proper traffic control or moving plant and equipment or other operations of the contractor then such surfaces shall be reinstated by the contractor at his own expenses. The surfaces shall be restored to their original condition using such materials as may be required whether obtained from the excavated materials or not.

**2.7.3 Maintenance of Traffic**

When the excavation is in roads, care shall be taken to cause the least inconvenience to traffic. When directed or necessary for the maintenance of traffic, the contractor shall remove from the site all materials as excavated from the trenches and return the same as necessary for refilling after the structures have been completed or the pipes tested and approved.

**2.7.4 Control of Traffic on Roads**

The Contractor shall ensure that the flow of traffic over the existing roads and access to properties is maintained at all times during the contract. The flow of traffic is to take place at all time over a reasonable surface, which is to be segregated as far as possible from areas where work is in progress. In the planning and execution of any temporary or permanent works, which may affect the traffic flow and / or access to properties, the contractor shall cooperate closely with the Engineer and the appropriate controlling Authority.

**2.8 MEASUREMENT AND PAYMENT**

The measurement and payment for different categories of earth excavation inclusive of disposal of surplus earth upto any lead or lift shall be done in accordance with BOQ rates.

Excavation shall be measured according to the net volume within the outlines as shown on the drawing. The rate for excavation entered in the Bill of Quantities shall include for excavation in all kinds of soils and removal surplus excavated earth/material as per instruction of Engineer and back filling.

Separate payment for back filling will be made to the contractor as per the BOQ and drawings.

For all works of excavation cutting or filling required to be carried out as per drawings, specifications or instructions of engineer which cannot be measured after carrying out of work,

the contractor shall arrange joint measurements with representative of Consultants. These measurements will be recorded in three copies duly signed by these three representatives and one copy to be retained by each. These joint measurements shall form the basis of agreement.

No payment will be made for such work for which joint measurement are not made and recorded. The surplus excavated material shall be utilized for filling as directed by the Engineer. The Contractor may also be required to excavated and remove some dumps / heaps of waste material which may cause obstruction in proposed pipe line. These removed materials shall also be used for filling. The measurements recorded shall form the basis of payment and

No payment shall be made in case joint measurements are not carried out and recorded.

All timbering, shoring, bracing etc. required for supporting the sides of excavation to prevent sliding or movement of soil shall be deemed to be included in the tendered rate of excavation.

Separate payment for dewatering, bailing and pumping will be made to the contractor as per BOQ item.

## **2.9 CUTTING & RESTORING OF ROAD AND MAKING DIVERSION**

### **2.9.1 General**

The Contractor shall arrange and provide adequate warning lights and signs to the satisfaction of the Engineer for the road cutting and diversion in the road from the start of the road cutting till it is restored to its original condition. Contractor shall be fully responsible for any damage or claim in case any accident takes place due to his negligence in not making proper arrangements in this regard.

### **2.9.2 Cutting and Restoration of Road**

Whenever a road is required to be cut for lying of pipeline or otherwise, prior intimation shall be given by the Contractor and approval taken from the Engineer. Also the Contractor shall have to obtain prior permission for cutting the road from the concerned department. The Engineer shall provide the required authorization for obtaining the required permission. Cutting of road, digging the trench to the required level, laying and jointing the pipe and backfilling and reinstatement work of the road shall be done as quickly as possible. After laying and jointing and testing of pipe, proper compaction of the backfill shall be done. Sub-base course and surface treatment of road in the reinstatement work shall be of the same quality and thickness as that of the original road. The Contractor shall follow the prevalent regulations of the concerned department of road in respect of the road cutting and reinstatement. In all cases Contractor shall carry out backfilling with required compaction. The sub-grade shall be prepared by using the dismantled hard crust of existing road. In case a cash deposit is required by the concerned department for road restoration work, the Contractor shall get the estimate of reinstatement of road cut prepared and submit the required cash to the department for obtaining the permission of road cutting. The actual amount of such cash deposit shall not be reimbursed by LARKANA Karachi to the Contractor along with the monthly running bills of the Contractor on presentation of actual paid vouchers.

### **2.9.3 Making Diversion**

Whenever a road is cut for laying of pipe or otherwise, a diversion of smooth and even surface is to be provided by the Contractor for the unhindered flow of normal traffic before the digging of road is undertaken to provide a good smooth road to avoid any inconvenience to traffic. On crossing of two way traffic road, only one side of the road shall be dug first. Full excavation, bedding and pipe lying should be done and got checked and backfilled and adequately compacted and opened to traffic. The other side shall be opened only after the first side is completed satisfactorily. Traffic diversion signs in bold letters with arrows shall be provided on both sides for convenience of traffic. For the work of laying pipelines along the road, the Contractor shall restrict the space required for excavated earth to minimum and provide a reasonable space for flow of traffic with all measures to protect any damage due to excavation work. Suitable pedestrian crossings shall be provided at reasonable spacing to reduce in convenience for public to minimum.

The Contractor shall have to maintain diversion in proper grade and level to the satisfaction of the Engineer from the beginning of the cutting of road and till it is restored to its original condition. Throughout this period any cut or depression formed on the surface shall have to be filled, watered and properly rolled to give a smooth surface. Continuous arrangements of sprinkling water shall be made to avoid formation of dust and dirt. The Contractor shall provide necessary diversion signs, fence, guards, flags, lights. The diversion shall be maintained with labor and staff round the clock for convenience of traffic. Cost of maintenance of diversion shall be included by the Contractor in his rates for excavation and shall also include arrangements for traffic directions. No separate payment shall be made for making diversion or arrangements for diverting the traffic. The Contractor shall provide adequate staff to meet with any emergency at all times round the clock.

#### **2.9.4 Payment**

The reinstatement work shall be required to be done by the Contractor only, when permissible by regulations of Larkana. Payment for each road cutting and reinstatement work if required shall be made as per approved tendered rates after restoring the road to the satisfaction of the Engineer. The work of reinstatement of road work shall be subject to the regulations of concerned department of Larkana.

The width of road cutting allowed for payment shall be same as allowed for payment of excavation of trenches.

No Extra payment will be made to the contractor for extra excavation of all concrete structure except shows in the drawings.

No separate payment shall be made for making diversion or arrangements for diverting the traffic for the purpose of execution of work.

## **SECTION – 3**

### **PIPES AND SPECIALS**

#### **3.1. M.S. PIPES**

##### **3.1.1 Mild Steel Specifications**

The pipes shall be made of Steel plate / coil X-42 of API standard No. 5 D Grade or PSS-0014-84.

##### **3.1.2 Chemical Properties and Tests**

The chemical composition of the steel shall fall within the following limits:

- Carbon - 0.28% max.
- Manganese - 1.25% max.
- Phosphorous - 0.04% max.
- Sulphur - 0.05% max.

##### **3.1.3 Mechanical Properties and Tests**

- Yield Stress - 42000 psi (min. psi)
- Ultimate Tensile Strength - 60000 psi (min. psi)
- Elongation on Gauge - 27 (min. %)

##### **3.1.4 Standard Specifications**

For sampling testing & tolerances limits, specifications No. AWWAC-200-80 shall be followed.

##### **3.1.5 Thickness of Plates / Coil**

Thickness of plate / coil shall be as specified in the respective items in the BOQ. All plates used shall be free of surface defects.

##### **3.1.6 Pipe**

The term pipe signifies a hollow cylinder made of M.S. Steel plate / coil of uniform internal dia. & having a uniform thickness of wall throughout its length.

##### **3.1.7 Diameter**

The internal diameter of the pipes shall correspond to the net specified diameter after protective lining.

The outside diameter of the body of the pipe as measured by taping the circumference shall be uniform.

##### **3.1.8 Lengths**

Pipes shall be finished in uniform lengths.

##### **3.1.9 Straightness**

The pipe shall be straight.

##### **3.1.10 Ends**

The ends of the pipe shall be so formed that when pipes of the same class and diameter are welded or jointed together to form a continuous straight conduit with a smooth & uniform interior surface.

##### **3.1.11 Joints**

Joints shall be welded as per AWWA specifications.

### **3.1.12 Manufacture of Pipes**

Before starting production of M.S. pipes the contractor shall furnish the following manufacturing procedure. This procedure shall include but not limited to the following information.

- i) Material quality, full details and checks analysis including residual elements.
- ii) Material manufacturing details.
- iii) Method of plate / coil forming.
- iv) Welding procedures, including procedures for skelp welding.
- v) Method & degree of coil expansion where applicable.
- vi) Method of straightening, sizing and hydrostatic testing.
- vii) Inside diameter.
- viii) Quality control and Inspection procedures. The submitted procedures and any agreed modifications shall be strictly followed in the production of pipes. The pipes shall be spirally welded with at least two welding passes, one of which shall be on the inside. The Contractor may propose straight welding for pipe manufacturing. This should be clearly mentioned in the tender submitted by the Contractor.

The Contractor shall submit all manufacturing procedures and qualification tests result to the Engineer for approval before the total production has exceeded 20 pipes. In the event test results are not available before production has exceeded 20 pipes, the contractor shall stop production and not restart until all test results have been approved by the Engineer.

The Engineer shall witness the manufacture and testing operation of desired quantity of pipes to verify compliance with the agreed procedure.

### **3.1.13 Internal Protection of Pipes – Cement Mortar Lining**

The internal cement mortar lining shall be applied in-situ of cement, sand, mortar 1:3 after completion of laying and backfilling of pipeline in trench, in continuity, in one course or more, by electronically driven lining machine traveling through pipe and centrifugally distributing the mortar uniformly across the pipe. The discharge shall be from the rear of the machine so that machine will be continuously fed with mortar by train of intermediate loading machine fed by Power Loader and high speed electric mixers, to achieve desired standard of lining.

The rate of travel of machine and rate of mortar discharge shall be mechanically regulated to produce a smooth surface and uniform thickness throughout. The lining machine shall have electronically controlled rotary trowels for smoothing of the lining so as to obtain William Hazel Coefficient in range 130-140. The mortar shall be densely packed and adhere wherever applied, there shall be no injurious rebound.

### **3.1.14 Lining Material**

#### **a) Sand**

Sand shall consist of inert granular material. The grains shall be strong, durable and uncoated. The sand shall be well graded and shall pass a No. 16 mesh screen, with not more than five 5 percent passing a No. 100 Sieve.

Graded sand will be bagged to ensure 1:1 mix while feeding the mixer.

Sand shall be clean and free from injurious amount of dust, clay, lumps, shale, soft or flaky particles, mica, loam, oil, alkali and other deleterious substances. The total weight of such substances shall not exceed three percent of the combined weight of the substances and the sand that contains them.

**b) Portland Cement**

Portland cement shall conform to type I or type II of ASTM C150 or shall be as otherwise specified by the Engineer.

**c) Water**

Water for mixing mortar shall be clean and free of mud, oil and injurious amounts of organic materials or the deleterious substances. Potable water shall be used.

**3.1.15 Mix for Lining**

**a) Composition**

Mortar for lining shall be composed of cement, sand and water that have been well mixed by the concrete mixer and shall be such consistency as to produce a dense, homogeneous lining.

**b) Proportions**

The approximate proportions of cement and sand in the mortar for the lining shall be 1 part of Portland cement to 1 part of sand by volume. The exact proportions shall be determined by the characteristics of the sand used as approved by the Engineer.

**c) Water Content**

The water content shall be the minimum that produces a workable mixture, with full allowance made for moisture collecting on the interior of the pipe surface.

**d) Mixing**

Mortar shall be mixed long enough to obtain maximum plasticity. The mortar shall be used well before initial set.

**3.1.16 Thickness of Lining**

The lining shall be uniform in thickness within the allowable tolerance, except at joints or deformations in the pipeline, at which places also the thickness shall be as uniform as possible to the satisfaction of the Engineer. Cement Mortar Lining thickness shall be as specified by AWWA C602-83 and approved by the Engineer.

**3.1.17 Curing**

Curing operations shall begin immediately following completion of the machine placement of the mortar lining in a section of pipeline. The section of pipe shall be closed with airtight cover over all openings and shall be maintained in a moist condition.

When a section of pipeline has been completed, the Contractor shall be responsible for careful curing of the mortar lining until the Engineer fills the section with water, or until the lining work has been accepted by the Engineer, but in no case for less than seven days.

**3.1.18 Cleaning of Pipe for Lining**

The interior surface of pipe to be lined shall be cleaned to remove corrosion products, chemicals or other deposits, loose and deteriorated remains of old coating materials, oil, grease and accumulations of water, dirt and debris. Shot or sand blasting is not required to prepare surface for lining.

**3.1.19 Machine Application of Mortar Lining**

The lining shall be applied in one course or more by machine traveling through the pipe and distributing the mortar uniformly across the pipe. The discharge shall be from the rear of the machine so that the newly applied mortar is not marked. The rate of travel of the machine and the rate of mortar discharge shall be mechanically regulated to produce a smooth surface and uniform thickness throughout to the satisfaction of the Engineer. The mortar is density packed and adheres wherever applied; there shall be no injurious rebound.

### **3.1.20 Guarantee and Performance Criteria**

Internal Cement Mortar Lining should be got done by an approved and specified firm, who must have proven past experience in machine application of cement mortar lining. During the warranty period if any damage occurs because of lining defect it shall be got rectified by the specialist company at no cost to the Employer. 15 years written warranty would be required to be provided by the specialist company with proven record. The Contractor will be allowed cement lining for individual pipes and specials in case of inclined or vertical length or for start length of pipes.

#### **3.1.21 Payment**

Payment for the internal cement lining and external protection of the steel pipeline shall be made for the acceptably completed work as per specifications at the approved tender rates, which shall include all costs for labor, material and equipments etc.

### **3.2. MILD STEEL SPECIALS**

#### **3.2.1 General**

The specials like bends; tees etc. to be used shall be manufactured with mild steel plates of specified thickness. Internal diameters shall be as given on the drawings or as directed by the Engineer. The Contractor shall submit shop drawing for all special before the manufacturing of special

#### **3.2.2 Quality of Steel**

##### **a) Chemical Properties**

All collars and specials shall be made from steel, the analysis of which shows not more than 0.06% of sulphur or phosphorous.

##### **b) Physical Properties**

The steel shall comply with the requirements as described for M.S. Pipes.

#### **3.2.3 Diameter**

The internal diameter of the specials and collars shall be as specified for pipes or as approved and directed by the Engineer.

#### **3.2.4 Joints**

The specials shall have standard flanges with holes at both ends and nuts and bolts with matching flanges provided with pipes. Plain ended bends shall be provided where specified for making weld joints or as approved and directed by the Engineer.

#### **3.2.5 Length / Width**

Length of each special and the width of the collar shall be as shown in drawing or approved and directed by the Engineer.

#### **3.2.6 Coating**

The internal and external coating for specials for rising main shall be same as provided for M.S. Pipes.

#### **3.2.7 Tests**

The specials and the pipes shall withstand a pressure of 61 meters.

#### **3.2.8 Payment**

The rates quoted for M.S. specials shall include cost of providing for material, labor, equipment including cost of cutting, rolling, levelling, chamfering, welding, drilling holes in flanges etc. complete including internal and external protection similar to M.S. Pipes mentioned in these specification cement lining. Payment shall be made as per tendered rates.

## **3.2 VALVES**

- 3.3.1 The valve body shall be made of cast iron of good quality from approved manufacture. The metal of casting shall be strong, tough, even grained, smooth surfaced and free from all defects without plugging or filling. All valves shall be flanged and conform to the dimensions of specials, fittings and pipes to be supplied and installed by the same Contractor. All valves shall be designed for a working pressure of not less than 100 psi and tested by hydro-statistically to a pressure of 200 psi. The marking cast on the body of valve shall indicate manufacturer's name, size of valve and designated working water pressure. Asphalt varnish shall be applied to the ferrous parts of the valve except bearing surfaces. Jointing material including nuts, bolts, washers and rubber packing shall be supplied in quantities required plus 10% extra.

### **3.3.2 Sluice Valves**

The sluice valves shall be in general conform to the requirements of BS 5163. The sluice valve shall provide an unobstructed waterway of same nominal diameter as of connecting pipe. The valve shall be provided with bronze seats accurately machined and fitted. The spindle shall be non-rising and shall be of solid forged bronze with a tensile strength of 28 to 30 tons per sq. in. shaped properly and machined all over with strong square threads to suit valve nut. The stuffing box shall be deep, large and liberal and capable of packing under pressure. The stuffing shall be properly packed and ready for service when delivered. The stuffing box packing shall be made of asbestos. Hemp or jute packing shall not be used. The valve shall be provided with cast iron cap for manual operation of the valve through key. One operating key of length of 3.28 ft shall be supplied free of cost. The valve shall open anticlockwise and close clockwise direction.

### **3.3.3 BUTTERFLY VALVES**

(Manually Operated) (Direct mounted Worm gear, Clockwise rotation to close).

1. All butterfly valves shall be of the double flanged, rubber sealed, droplight closure type.
2. Valve shall be drop-tight at rated pressure with flow in either direction and shall be satisfactory for duties involving flow regulation and frequent operation.
3. Valve shafts shall be of stainless steel operating in self lubricating bushes. Shaft seals shall be designed for the use of standard split-V type packing or 'O' ring seals. The design of the shaft seal shall be such as to allow replacement of seals without removing the valve shaft.
4. Disc seals shall be removable and made of high quality nitrile rubber attached to the disc edge by a retaining ring.
5. Disc shall be of ductile iron and have curve streamlining to minimise the head loss. Seat shall be of red brass and secure to valve body by corrosion resistant screws.
6. The valve body shall be of Mehanite cast iron and shall be capable of with-standing a test pressure of 10 bars without leakage.
7. Bearing shall be of special type self-lubricating to carry the stub shafts and shall be designed to ensure good bearing performance at maximum hydraulic head.

### **3.3.4 Gate Valves**

Gate valves shall generally comply with BS 5163. Valves shall be of the non-rising stem type with flanged ends to BS 4504 PN 16. The body, wedge, bonnet, stuffing box, gland and thrust bridge shall be of best quality cast iron to BS 1452 Grade 14, the seats, nut, faces and guides of gunmetal to BS 1400 Grade LG2-C and the stem of forged bronze to BS 2872 Grade CZ114. Each valve shall have a drain plug fitted at the bottom of its seating along with proper arrangement of disposal of drain water. Stuffing boxes shall be designed to have soft packing fitted. Valves shall be rated for 20 bar maximum working pressure with the bodies capable or withstanding a test pressure of 30 bars and the seat 20 bar without leakage.

### **3.3.5 Air Release Valves**

Air release valves shall be of 4 inches and 6 inches diameter double acting float type having a cast

iron body and bolted cover, bottom inlet, a ball float and valve operating mechanism. The float and all parts of the valve and operating mechanism shall be made of non-corrodible materials. Every valve must be tested to required pressure before installation. All air valves shall be fitted with isolating gate valves of 4 inches and 6 inches diameter.

### **3.3.6 PENSTOCKS (INCLUDING SLUICE GATES)**

#### **GENERAL**

- a) Penstocks shall be of robust design, suitable for their application, and their construction shall be capable of resisting deflection under the worst operating head conditions. Each penstock shall be provided with a suitable handwheel of adequate diameter for the duty required. To be to BS 7775: 2005 .

Penstocks shall carry identification marks and/or brass plates to identify the penstock number and function.

- b) All penstocks shall be clockwise closing.
- c) Gearing shall be supplied where necessary to ensure that the required operating force applied by hand to the rim of the wheel does not exceed 25kgf. If the handwheel cannot be readily accessed, extension spindles, headstocks and foot brackets shall be provided where specified.
- d) Penstocks shall be fabricated stainless steel 316L to BS EN ISO 10088: Where applicable the penstock shall be electrically actuated. The handwheel shall have the direction of closing cast thereon. Bituminous paints shall not be applied to the handwheel.
- e) Penstocks spindles specified to be key operated shall be fitted with stem caps. The caps shall be drilled and each provided with nut and bolt for securing to the spindle, which shall likewise be drilled to accept the bolt. Where caps are fitted, they shall be supplied complete with operating tee key. The extended spindle shall be such that the tee key will be operated at 0.9-7.2 metres above floor level.
- f) The penstocks shall be supplied complete with all accessories, fittings, fixing bolts, nuts and washers ready for installation. Fixing nuts and bolts shall be supplied by the manufacturer and shall be of stainless steel 316L.
- g) The penstocks shall be wall or channel-mounted full frame "Flush Invert" type suitable for extended operation.
- h) They shall offer excellent corrosion resistance, be lightweight in operation and require minimum maintenance.
- i) The doors shall be designed for ON or OFF seating pressures, suitable for an off-seating head of 8.5m. The seals shall be watertight under these conditions for head and direction of flow.
- j) Thrust tubes shall be provided between the penstock frame and headstock in order to absorb the thrust in both directions of operation. Thrust tubes shall incorporate all necessary fixing brackets and spindle guide plates.

- k) Penstock welding to be in accordance with BS EN ISO 15614.

#### **3.3.7 Pressure Seals**

- a) The unseating sides of the frames shall be fitted with adjustable pressure seals. Frame seals shall be EPDM and shall be fitted with corrosion resisting retaining strips and stainless steel 316L fixing bolts. The seals shall be readily adjustable in situ using adjustable stainless steel fasteners, which shall be replaceable. The seals shall not project into the flow through the penstock aperture.
- b) The invert seal shall be EPDM.

#### **3.3.8 Drive Spindle and Nut**

- a) Penstocks shall be of the rising spindle type with the lifting bracket securely bolted to the top of the door with stainless steel fasteners. The spindles shall be manufactured from stainless steel, machined all over, with a machine cut robust trapezoidal or square form thread, operating in a gunmetal nut. Polyethylene or similar materials are not permitted
- b) All spindles shall be protected by a protection tube complete with position indicator end cap and grease nipple. Where the spindle length exceeds 2.5m, guide brackets shall be provided for the drive spindle and shall be bushed with aluminium bronze or similar non-ferrous material. These shall be of the split bearing type.

#### **3.3.9 Fixing Bolts**

The penstock frame shall be fixed by stainless steel anchor bolts or encapsulated epoxy resin bonded type. The design of anchor bolts shall be such that a minimum of civil preparation will be necessary for satisfactory erection of the penstock.

#### **3.3.10 Headstock Pillar**

- a) Fabricated mild steel or cast iron pillars shall be provided for the mounting of the drive gear on the penstock.
- b) The penstock frame shall be fabricated from 316L stainless steel sections. All welds shall be continuous and adequate drainage of hollow sections shall be provided where applicable. Any strengthening of doors by the provision of ribs and gussets shall be carried out by welding and not by bolting.
- c) The penstock door shall be stainless steel sandwich construction. The door shall be stiffened by a steel matrix in a chemically bonded filler of rigid cellular polymer. The matrix shall be grit-blasted before polymer filling. Both outer faces of the door shall be protected with stainless steel sheeting.
- d) The door shall have sufficient strength to withstand the working pressures without significant deflection or distortion.
- e) The side sealing faces may consist of simple metal-to-metal contact between the door and frames or of synthetic rubber seals and plastic guides as necessary to withstand the required working pressure without leakages.

- f) Penstocks shall be prepared and painted in accordance with Section 15004: Corrosion Protection.

### **3.3.11 Actuators**

#### **Electrical**

- a) Valve actuators shall be directly mounted onto and supported by the valves that they control, unless the valve is underground where the actuator shall be mounted at coping level. Actuators shall be suitable for remote automatic control and shall incorporate means for local manual operation using a handwheel or lever. Actuators shall have integral starters and control equipment, unless the actuator motor is of a size that necessitates a panel-mounted starter, in which case it will be specified in the particular specification.
- b) The output shaft shall be hollow to accept a rising stem and incorporate thrust bearings of the ball or roller type.
- c) The design shall permit the gear case to be opened for inspection or disassembled without releasing the stem thrust or taking the valve out of service.
- d) Valves stems and threads shall be provided with grease lubrication, rising spindle valves being protected with a totally enclosed grease packed cover tube.
- e) The actuator shall be fitted with a drive bushing which is easily detachable for machining to suit the valve stem or gearbox input shaft. Bushing shall be fitted in the base of the actuator to enable standard length valve stems to be used.
- f) Only two categories of sealing are permitted:
  - i. All equipment selected for use in a hazardous area shall have undergone an appropriate conformity assessment procedure (CAP) to demonstrate compliance with the essential health and safety requirements of European Directive 94/9/EC (ATEX 95), as enacted in the UK by the Equipment and Protective Systems Intended For Use in Potentially Explosive Atmospheres Regulations 1996 and the Equipment and Protective Systems (Amended) Regulations 2007.
  - ii. Watertight, dust-tight complying with the requirements of BS EN 60529 IP67 or better.
- g) Actuators shall be suitable for pedestal mounting and interchangeable without removal of the associated valve, penstock, pedestal, etc.
- h) Actuator mounting flanges to be to BS EN ISO 5210 for multi turn actuators and BS EN ISO 5211 for quarter turn actuators.
- i) Sealing of static joints shall be by 'O-ring' on moving components to prevent leakage of lubricant from the machine.
- j) The actuator shall provide double sealing between the terminal compartment and the internal electrical elements of the actuator, fully protecting the motor and all other

internal electrical elements of the actuator from ingress of moisture and dust when terminal cover is removed on site for cabling.

- k) For control purposes, limit switches shall be fitted to the actuator at both the closed and opened positions of the valve. Limit switches shall also be fitted for signalling purposes. All these shall be fitted internally. Limit switches contacts shall be volt-free. The switch contact rating shall be 5A, 250V a.c., 30V d.c. Valve position shall be clearly marked externally on the actuator.
- l) The actuators shall be sized so that they develop sufficient torque to reliably seat/unseat the valve or penstock off its seat, and to provide adequate torque throughout its operating range. The torque output must be at least 20% more than is required under maximum operating conditions (i.e. maximum differential head). The drive shall incorporate a lost motion hammer blow feature.
- m) Adequate overload protection shall be provided to prevent actuator motor damage in the event of seizure. This shall either be in the form of torque switches or over-temperature thermostats. The torque switch shall latch out on operation, and to be reset by driving in the opposite directions. A mechanical latch shall be provided to prevent the open torque switch tripping while the initial unsealing hammer blow is applied.
- n) Setting of the torque and limit switches shall be carried out without the requirement to remove any electrical compartment covers.
- o) Adjustable mechanical limit stops shall be provided for opened and closed positions of actuators.
- p) Actuators supplies shall be 415V, three-phase or 110V single-phase or less for quarter-turn and 415V, three-phase for multi-turn.
- q) The Motor shall have Class F insulation in accordance with BS 2757 and shall be rated for a Class B (80K) temperature rise. Temperature rise shall be measured by the resistance of the windings during full load conditions, in accordance with BS EN 60034-7.
- r) Actuators in hazardous Areas shall be in accordance with ATEX11 2G EEx de 11CT4 in accordance with EN 50014, EN 50018 and EN50019.
- s) Certain valve actuators will require fail-safe operation in the event of an electricity mains failure. The Contractor may achieve this either by using fail-safe actuators or by providing standby power supplies for the affected actuators. There should be no tendency for any actuator to "creep" either opened or closed, both in normal operation or under mains failure conditions.
- t) Anti-condensation heaters for use on 110V a.c. shall be provided for all actuator motors.
- u) The actuator motor gearbox shall be of the total enclosed oil bath lubricated type suitable for operation at any angle and provided with appropriate filling and drain plugs.

- v) A handwheel shall be provided for manual operation of the valve. It shall not operate during powered actuator movement by way of a positive means of disconnection from the motor driven mechanism. The wheel shall be maintained in its engaged position once this is selected until powered movement takes place when it shall automatically disconnect and "free wheel". The hand wheel gearing shall be selected to allow valve operation without undue effort i.e. not exceeding 25kgf.
- w) The hand wheel shall be provided for manual operation of the valve in accordance with BS EN 12570. Hand wheel gearing shall enable one person to manually open/close the valve without undue effort and in a reasonable time period, in accordance with BS EN 12570.
- x) It shall be possible to secure hand or powered operation by means of padlocking in the selected mode.
- y) Where necessary to present the actuator hand wheel at a convenient operating height, flange-mounted pillars shall be provided which fully enclose the necessary valve stem extension spindles. Supplementary support of the extension spindle within its pillar shall be provided for long shafts.
- z) The open/close direction of rotation shall be clearly indicated on the hand wheel.
- aa) A visual position indicator shall be provided within the actuator, complete with a pointer showing opened/closed and in travel positions, and a sealed potentiometer to transmit continuous remote position, where necessary. Where specified in the particular specification, this indicator shall be illuminated.
- bb) Electrical and mechanical disconnection of the motor should be possible without draining the lubricant from the actuator gear case.
- cc) Modulating duty actuators shall be capable of 3000 operations per hour as a minimum.
- dd) Standards BS2757- Method of determining the thermal classification of electrical insulation.

BSEN 12570- Industrial Valves. Method for sizing the operating element.

BSEN 60034-1- Rotating Electrical machines. Rating and performance.

BSEN 60947-7- Specification for low voltage switchgear and control gear.

Ancillary equipment

BSEN ISO 5210- Industrial Valves. Multi turn valve actuator attachments.

BSEN ISO 5211- Industrial Valves. Part turn valve actuator attachments.

### **3.3.12 Pneumatic**

- a) Air actuators shall only be used where specified in the particular specification and shall be of the double acting type and be field interchangeable without the necessity of removal of the valve or penstock.

- b) Where a pneumatic actuator is used for modulating control it shall be fitted with integral feedback.

### **3.3 PAYMENT**

No advance payment shall be made to Contractor except as allowable under the conditions of contract. Part payment will be allowed for material at site brought or imported and transported to Contractor's store at site approved by Engineer duly provided with watch and ward and protection arrangements.

## SECTION- 4

### uPVC PRESSURE & RCC PIPES

#### 4.1 SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all the operations in connection with laying, jointing, testing, disinfection and commissioning of uPVC pipe work complete in strict accordance with the specifications herein and the applicable drawings and subject to the terms and conditions of the contract.

#### 4.2 UPVC PIPES

UPVC pipes shall be approved manufacture and confirm to the standard as specified in General section.

#### 4.3 STANDARDS AND SPECIFICATION

For sampling testing and tolerance limit, specification BS: 3505:1968 and PS 3051 1991 shall be followed. The uPVC pipes jointing shall be cement solvent joint or Z- joint. The contractor should provide the Technical Detail and Boucher to the Engineer or Engineer's representative for approval.

#### 4.4 PHYSICAL PROPERTIES

The physical properties of uPVC pipes shall fall within the following limits

Properties	Value	Unit
Specific Gravity	1.42 - 1.46	-
<b>MECHANICAL</b>		
Tensile strength at 23 °C	450 – 600	kgf/cm <sup>2</sup>
Modulus of elasticity at 20°C	30,000	kgf/cm <sup>2</sup>
Elongation at break	> 80	%
Impact strength at 0°C	0.5 – 1	Ft lb / in of notch
Impact strength at 20°C	1 – 2	Ft lb / in of notch
Compressive strength	600 – 700	Kgf/cm <sup>2</sup>
Bending Strength	1000	Kgf/cm <sup>2</sup>
<b>THERMAL</b>		
Specific heat at 20°C	0.24	Cal/gm/°C
Vacate softening point	85	°C
Heat distortion temperature at 18.5 kgf/cm <sup>2</sup>	75	°C
Thermal conductivity	0.12 – 0.14	W/m °C
Coefficient of linear thermal expansion	0.08	Mm/mm°C
<b>ELECTRICAL</b>		
Dielectric constant (800 cycle)	3	-
Dielectric strength	425	Volts/mil
Inflammability	Will not support combustion	-
Water absorption (24 hrs at ambient temp.)	0.07	%

#### 4.5 ABBREVIATIONS

uPVC	Unplasticized polyvinyl chloride
PVC	polyvinyl chloride
BS	British Standard
PS	Pakistan Standard
OD	Outside diameter

PN Nominal Pressure

#### 4.6 Nominal Pressure (PN)

The following class/pressure shall be followed

Class B (PN=6 bars),

Class C (PN= 9 bars)

Class D (PN=12 bars),

Class E (PN= 15 bars)

#### 4.7 THICKNESS AND DIAMETER

The diameter and thickness shall be as followed

Nominal size	Mean Outside Diameter	Wall Thickness			
		Class B 6 bar	Class C 9 bar	Class D 12 bar	Class E 15 bar
	max	min	min	min	min
Inch	mm	mm	mm	mm	mm
3"	89.1	2.9	3.5	4.6	5.7
4"	114.5	3.4	4.5	6.0	7.3
5"	140.4	3.8	5.5	7.3	9.0
6"	168.5	4.5	6.6	8.8	10.8

#### 4.8 UPVC FITTINGS

uPVC fittings shall be approved manufacture and shall be confirm to the standard as specified in General section I For sampling testing and tolerance limit, BS and PS Specification shall be followed. Metal fittings (cast iron and ductile iron fittings) can be used for diameter ranging 10 inches and above. The metal fittings are connected with the pipe using rubber ring Z-joint system.

#### 4.9 JOINTING

##### 4.9.1 Solvent Cement joint

Jointing is done by applying a uniform layer of solvent cement to spigot and socket ends of pipes to be jointed together and assembling them with a quick action. Right after jointing, the surplus cement shall be removed and a period of 24 hours should be allowed to elapse before pressure testing. It may be noted that completion.

##### 4.9.2 Guide to the Consumption of Lubricant, Cleaner and Solvent Cement per 100 Joints

Range of pipe and fittings diameter (mm)

Aprox.	32 – 40	50 – 63	75 - 90	110 – 125	140 - 160
	1" – ¾"	1" – ½"	2 ½" – 3"	4"	5" – 6"
Lubricant (kg)	-	2.0	3.50 – 4.00	4.00 – 5.00	5.0 – 6.5
Cleaner (liter)	0.35 – 0.50	0.65 – 0.90	1.00 – 2.00	3.00 – 5.00	6.5 – 9.0
Solvent Cement (Liter)	0.78 – 1.00	1.30 – 1.800	2.00 – 4.00	6.00 – 10.00	13.0 – 18.0

##### 4.9.3 Z-joint

Z – Joint is also commonly known as "rubber ring" joint. These joints contain an electrometric sealing component which is automatically compressed to form an effective seal when the spigot end of uPVC pipes inserted into the socket.

These joints are not designed to resist end thrust. Therefore, particular care should be taken to ensure that the pipeline is property anchored. Anchor blocks should be designed to withstand

the thrust resulting from the maximum pressure to which the pipe is likely to be subjected, normally the test pressure. It is desirable to insulate the uPVC pipe from direct contact with the anchor block by means of a suitable flexible membrane.

#### **4.9.4 Flanged Joint**

Flanged joints can be used to connect uPVC pipes with metal pipes, valves and fittings provided with flanges. Joints are made by the compression of the gasket or a ring seal set in the adaptor of the flange. Flanged joints are also preferable, where there is a need to dismantle pipeline from time to time. Care should be taken while selecting flange accessories their flange should be compatible with the uPVC flange adaptor.

#### **4.10 DISINFECTION PROCESS**

Disinfection shall be effected by filling the pipeline with water heavily dosed with chlorine and shall be carried out when filling the pipeline with water for carrying out the hydraulic test on completion. Alternative methods may be adopted with approval of the engineer.

The level of the chlorine dosing shall be such as to make available 50mg/l of free chlorine throughout the pipeline.

The water heavily dosed with chlorine shall stand in the pipeline for a period of 24 hours for such longer period as the engineer shall require and all valves in the system shall be operated at least once during this period.

At the termination of the required period, chlorine residual test shall be taken at the end of the pipeline farthest from the point of injection and the test shall be repeated if necessary until the residual is not less than 10mg/l.

The contractor shall obtain the engineer's approval to the method to be adopted for disposing of the chlorinated water and the time when such disposal shall take place on completion of disinfection.

Connections of the new mains to the existing shall only be made when disinfection has been satisfactorily completed. Absolute cleanliness is essential. No groundwater shall be allowed to come in to contact with the water main pipes. All cut ends or newly exposed parts of the pipes or fittings shall first be thoroughly cleaned to remove swarf and other extraneous matter, and then sprayed with a 10% hypochlorite solution. All couplings and make up pieces and tools shall be cleaned and sprayed with 10% hypochlorite solution prior to fixing. The newly made joint shall be put under operating pressure as soon as possible and checked for leakage.

#### **4.11 INSTALLATION OF uPVC PRESSURE PIPES**

##### **4.11.1 Installation Of Buried Pipe**

Un-plasticized PVC pipes must be laid onto a trimmed trench bottom, where soil is uniform, fine grained and free from sharp objects. The trench width must be sufficient to enable the laying and jointing of the pipes and proper compaction around the pipe. The minimum recommended trench width (W) is equal to pipe OD plus 600 mm or as specified in the Drawings

The minimum depth of cover required for water mains is 900mm from finished surface level to the crown of the pipe. Thus, the minimum excavated depth (D) of the trench for water mains is pipe OD + 900mm + Bedding.

The normal thickness of bedding is a min of 100mm. for pipe sizes greater than 8 inches; the bedding thickness should be increased to a minimum of 150mm and or specified in the Bill of Quantities.

Because of the flexible nature of the material the pipe should be suitably anchored at all changes of direction and at fixed points. The anchors should be designed to withstand the maximum thrust developed during hydrostatic pressure testing.

Un plasticized PVC pipes should not be installed in direct sunlight or near any heat source. The

liner expansion of uPVC is about six to seven times that of steel, so precaution is to be taken to compensate for it. The pipe line should be installed in such a way as to minimize the stress. The best way of doing this is to arrange piping so that bends occur between anchor points. Along walls pipe rack, hangers, clamps, straps or u-bolt can be used.

#### 4.11.2 Support Spacing

Recommended horizontal and vertical support spacing is given in the table.

*Pipe Outside Diameter	Water Temperature °C				Vertical spacing
	20 °C	30 °C	40 °C	50 °C	
OD	Horizontal Spacing				
mm	cm	cm	cm	cm	cm
16	75	60	40	-	80
20	85	70	50	-	90
25	90	75	55	45	100
32	100	85	65	50	120

#### 4.12 R.C.C PIPES.

Pipes for sewers shall be of RCC manufactured in SR cement from approved pipe factory. The pipes shall conform in all respects to ASTM C-76/ BS 5911. The thickness of barrel of sewer pipe shall be 30% more than the thickness proposed in ASTM C-76 for the same internal diameter of pipe. The pipes shall be socketed for push on rubber joints. The Contractor shall submit with his tender a detailed sketch of R.C.C. pipe with statement indicating details of socketed joints and also details of reinforcement including numbers and diameter of horizontal and spiral bars for each diameter of pipe. Conforming the requirements All R.C.C. pipes shall be manufactured with S.R cement.

The Contractor shall supply the required number of rubber rings of size and dimension suitable for the diameter of pipe provided for making a fully watertight joint. The rubber ring shall comply in all respect with BS 2494 or equivalent, approved by the engineer.

#### 4.13 MEASUREMENT

- All pipes shall be measured according to the work actually done and no allowance will be made for any waste in cutting to the exact length required. The measurement for pipes shall be in running meter nearest to a cm Of length along the centre line of pipe as actually laid at work sites.
- The rate for providing, laying and jointing of pipes shall be deemed to include the cost of collars/rubber rings/cement solvent, jointing material, testing and extra excavation required for ordinary bedding of pipes and also for collars and pipe sockets, if any.
- If any damage is caused to the pipe line during the execution of work or while cleaning/testing, the pipe line as specified. The contractor shall be held responsible for the same and shall replace the damage pipe line and retest the same at his own cost to the full satisfaction of Engineer.
- Water for testing of pipeline shall be arranged by Contractor at his own cost.
- Pipes shall be brought on site proportionate to the required progress for Thirty days only.

## SECTION – 5

### LAYING, JOINTING & TESTING OF PIPES, VALVES AND FITTINGS FOR RISING MAINS AND SEWERS

#### 5.1 SCOPE OF WORK

This Section covers transportation of pipes and accessories site of work, handling, cleaning, lowering in trenches, making alignment, cutting, jointing setting of valves, fittings, pressure pipes and sewer pipes and gravity mains including testing and commissioning and handing over / taking over in strict accordance with specifications and condition of the contract or as directed by the Engineer.

#### 5.2 ALIGNMENT AND GRADE

The pipes shall be laid in trench to the required level slopes, lines, alignment and grades at the required location as shown in the drawings or as directed by the Engineer or his representative(s).

#### 5.3 CLEANING AND CHECKING OF PIPE AND FITTINGS

All pipes shall be brushed and wiped clean before the pipes are laid. Before laying all pipes shall be inspected for defect and when required by the Engineer shall be tapped with a light hammer to detect cracks. The pipes and fittings found containing any defects shall be removed from the site to be replaced with defect free items which shall be got inspected in the same way as described above.

#### 5.4 BEDDING FOR PUMPING AND GRAVITY MAINS INCLUDING SEWERS

In all types of soils above water table and hard soil that can stand vertical without support, the pumping and gravity mains including sewers shall be laid on approved granular bedding. This bedding material shall consist of broken stone or gravel mixed with coarse sand. The materials grading shall be in accordance with BS 410 and as described in Section II. The material should be free from dust, plants or any organic compound etc. The thickness of bedding material below the pipe shall be up to full width of trench and shall be thoroughly compacted up to 95-100 % as per AASHTO Standards after laying pipes, further granular bedding shall be laid and compacted in a similar manner to fill the entire space between the pipes and un-disturbed sides of trench up to a depth equal of half ( $\frac{1}{2}$ ) of the outer diameter of pipe. Adequate space as prescribed by the Engineer shall however be provided for pipe socket at required points.

If the granular bedding material is contaminated by water, sewage or soil materials due to the collapse of the sides of the trenches it shall be removed from the trench and replaced with new material before any of the pipes are laid or re-laid.

#### 5.5 BEDDING FOR PUMPING AND GRAVITY MAINS IN SOFT SOIL BELOW GROUND WATER TABLE

In case the invert of pipes is below ground water table or stable strata are not available at the pipes invert level, the same shall be supported on the following bedding:

##### 5.5.1 Concrete bedding

In case the pipe is required to be laid below ground water table where the sub soil unstable and may cause formation of slush during the excavation and dewatering a bed of concrete of 1:3:6 shall be provided for laying pipes in the trenches. The thickness of this concrete bed shall be as under:

200 mm for all sewer pipes upto 300 mm internal diameter. 300 mm for all sewer pipes exceeding 300 mm internal diameter.

This concrete bed shall be laid over a stone soling 225 mm to 450 mm thick packed layer granular bedding unto half or three quarter of the pipe over the concrete bedding as directed by

the Engineer shall be provided.

The concrete bed shall be laid in full width of trench and adequately vibrated as per direction of the Engineer / Engineer's representative present at site. Space shall however be provided for pipe sockets at required places.

After laying pipe sewer, further cement concrete of mix 1:3:6 shall be placed and vibrated in a similar manner to fill the entire space between the pipe and the undisturbed sides of trench up to depth equal to  $\frac{1}{4}$  of the outer diameter of the pipe or as directed by the Engineer in writing depending upon the stability of the strata encountered at each individual location.

The Engineer can however reduce or increase to any required extent the thickness or width of concrete granular bedding below pipe or depth of granular bedding or, concrete on the sides of pipes through instructions in writing and the Contractor shall be paid accordingly.

In case of excessive slush formation in the trench for which the Engineer, who shall be the sole judge may instruct in writing to lay gravel or stone soling below the bed of concrete. This shall be done after detailed inspection of excavated trench by the Engineer. The Engineer shall instruct the depth of such bed of gravel or soling in writing before laying the bedding. No payment of bedding shall be made if no such written instruction specifying depth, width and length of bedding and its location is specified by the Engineer.

#### **5.5.2 Concrete Encasing for Pipes**

When directed the Contractor shall encase (surround) pipe with concrete. The concrete for surrounding the pipes shall be 1:1½:3 ratio (grade 30) to the dimensions given in the drawings or as directed by the Engineer.

- 5.5.1 For pipes less than 1000 mm Internal diameter the cradles shall be 150 mm wide and a minimum of 300 mm long. For pipes 1000 mm diameter and above cradles shall be 200 mm wide and a minimum of 600 mm long or as directed by the Engineer.
- 5.5.2 Neither trench sides nor trench timber or sheeting to be used in lieu of proper formwork to concrete surrounds. All spaces at the sides or in other places shall be filled up with selected fine material and the ground made solid as the work advances. No extra payment will be made for the concrete in excess than shown in drawings.
- 5.5.3 Concrete shall be placed evenly over the entire width of the surround (encasing) and to within 25 mm of the bottom of the pipe then without stopping. It shall be placed gently on one side of the pipeline only and carefully worked under the pipe ensuring that no voids are left under the pipe. The concrete shall be brought up equally on each side of the pipe to the required finished height.
- 5.5.4 Horizontal construction joints will not be permitted in the concrete surround below half pipe height. Vertical construction joints shall be formed only at each pipe joint and must extend through the blinding where appropriate Diaphragm of approved compressible expansion jointing material cut to the exact shape of the outside face of the pipe and the bedding surround shall be positioned and supported in contact with the end face of each socket. The contractor shall take precautions to ensure that a firm seat exists between the diaphragm and the end face of the socket and that no concrete intrudes into the joint. Flexible joint at the pipe joint should be provided all along the concrete encasing and concrete bedding as specified by the Engineer.

#### **5.6 PLACING AND LAYING**

Pipes, specials and fittings where applicable shall be carefully lowered into the trench by means of derrick, rope slings, or other suitable equipment. Under no circumstances shall any of the pipeline or any materials be dropped, dragged or dumped into the trench. The full length of each section of pipe shall completely rest upon the pipe bed with recesses excavated to accommodate joints. Pipe that has the grade or joints disturbed after laying shall be taken up and re-laid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. The sewer pipes shall be correctly laid in correct position, alignment, level and grade and

checked so that the invert of the sewer conform to that shown on the drawings and sockets are placed on the places provide for them in the excavation and the complete sewer will have smooth and uniform inverts. Each pipe shall be inspected for defects before being put in place.

- 5.6.1 In laying out pipes, fittings and specials they shall not be allowed to impede or harm traffic pedestrians or animals or to obstruct paths and access to private and other property. Pipes shall not be laid out in beds of watercourses and every precaution shall be taken to preserve their sound and perfect condition before laying.
- 5.6.2 Trench excavation and pipe laying shall proceed in an orderly and continuous fashion working from one end of the pipeline to the other. Piecemeal excavation and pipe laying of isolated lengths will not be permitted prior to written approval of the Engineer. Similarly manhole / chamber foundation bases shall be correctly proposed to avoid cutting of pipes wherever possible.

#### **5.7 LAYING PIPES ALONGSIDE EXISTING PIPES AND SERVICE ETC.**

Where new pipes are to be laid alongside, over or under existing sewer, surface water drains, nallahs, water or gas mains, conduit electric cables or telephone cables, the contractor shall take care to interfere as little as possible with the existing services and connections thereto and the Contractor shall repair, or arrange for the repair of any damage to the satisfaction of the utilities owner and the Engineer.

The contractor shall make all arrangements for supporting existing services and for temporarily dealing with the flow from any pipe, drain, nallah, channel, etc. and shall provide all troughs pumps plant and material necessary for this purpose.

#### **5.8 LAYING PIPE UNDER HEDGES. FENCES. WALLS AND NEAR TREES**

Where hedges are damaged or destroyed the whole shall be restored and reinstated with two rows of the same kind as the hedges, planted in due season in topsoil 300 mm deep and fenced on each side with post and wire Stock proof fences finished on top with one strand or galvanised barbed wire, or otherwise protected as required by the owners or occupiers and the Engineer.

Where fences or walls are damaged or destroyed, the whole shall be restored and reinstated with like materials to the satisfaction of the owners or occupiers and the Engineer.

#### **5.9 LAYING PIPES THROUGH WATERCOURSES CANALS ETC.**

Work shall be carried out in such a manner that in the opinion of the Engineer, the watercourses are left unimpeded and their appearance and use unimpaired. The work shall be so completed that the trench line cannot in the opinion of the Engineer, be eroded, and water cannot seep along the trench line.

The top 600 mm of the trench shall be refilled with clay puddle to the watercourse bed level and for at least two meters into each bank.

The pipeline shall be laid with a minimum, cover a indicated on the Drawings under the base of watercourse, canals, etc. and surrounded with concrete for distance extending into the banks as far as the Engineer may determine at site. Different types of materials excavated from the bed of the river shall be set on one side separately and after the pipe surround has been completed. The trench shall be backfilled and consolidated in such a way as to restore as far as possible each type of material of which the bed is composed to its original position and state of compaction.

The contractor shall submit Methodology of all temporary works he intends to construct to maintain the flow in watercourse during construction of the work for the Engineer's approval.

Where a pipeline runs parallel to a watercourse, the distance between the edge of the ditch and the edge of the-pipeline trench shall not be less than either the depth of the ditch or the depth of the pipeline trench, whichever is greater.

## **5.10 LAYING PIPE ACROSS RAILWAYS**

Where any pipe crosses a railway or work is carried out within railway property, the work shall be carried out in an approved manner and to the requirements and satisfaction of Pakistan Railways and their Engineer.

Details of the method of working and any particulars that Pakistan Railways may request shall be furnished to their Engineers, and approved by them before work commences. After approval has been received the contractor shall give written notice to Pakistan Railways of at least one month, or longer, if required, of his proposed date of commencing work on any crossing.

## **5.11 JOINTING**

After a length of pipeline is laid in trench, the pipe specials, and fittings, shall be jointed in accordance with the recommendation of the manufacturers of pipes. The welding of M. S. pipe work shall be done as per BS 2633 wherever provided.

Both sewer pipes, socketted or collared, shall be jointed with rubber rings. Rubber ring shall be mounted on the spigot end, socket of pipe or collar as required and pipe be pushed into socketted /collar after lubrication of approved quality as approved by the Engineer in writing, to form watertight joint. For cut pipes of RCC for sewers the contractor may provide a collar joint for connecting the pipes only on written approval of the Engineer. The adjacent ends of cut pipes shall be butted together concentrically so that a dowel is left between the two ends. Jute or hemp yarn soak in cement or melt bitumen shall be wound in the dowel spaces and joint smoothed with cement mortar (one part of cement and 1½ parts of fine aggregate). The RCC collar shall be carefully pushed in position and the space between the pipe and the collar shall be filled and adequately caulked with cement mortar 1:1½ so that even space appears all around the external diameter of pipe. The work of jointing / working joints shall be done only in the presence of the Engineer's representative (s). Any joint not made in presence of Engineer's representative shall be rejected and will have to be dismantled and remade at the Contractor's risk and cost.

The open ends of pipes being laid for sewers and pumping / rising main after a day work shall not be left open by the Contractor. These open ends shall be carefully closed adequately by wooden plug of appropriate size to stop and sand, garbage, debris, insects, animals or water entering in the pipe. No payment shall be made for such plug that shall be watertight. The cost of providing and dismantling of such plugs shall be deemed to be included in Contractor's rate of laying and jointing of pipes or sewers. Where shown on the drawings flanged joints shall be provided. The flanges shall face parallel. The faces of the flanges shall be cleaned and wiped. Proper gasket shall be inserted between the flanges and bolts shall be installed and nut tightened in opposite pairs to form fully watertight joints.

On completion of joints in a section or whole of pipeline backfilling shall be done for the length of pipe except joints which shall be kept open till the pipes or sewer line is pressure tested and approved. All valves on rising or pumping mains shall be laid and jointed as shown in the drawings or as specified by Engineer. Unless otherwise detailed, all pipelines shall have approved flexible joints.

All joints shall be sound and watertight when subject to pressure test and under all working conditions. Before any pipe joint is made, the ends of the pipes to be jointed shall be thoroughly cleaned. Care shall be taken to ensure that the rubber rings, when finally fixed, shall be concentric with the pipe.

Flanged joints shall be liberally coated externally with two coats of bituminous paint or other approved protective coating. Care shall be exercised to ensure that, with flexible rubber ring joints of all types, the pipe spigots are not driven tight home. The correct space as recommended by the manufacturer, between the spigot end and socket shoulder, shall be maintained.

**5.12 CUTTING OF PIPE**

The cutting of pipe shall be done neatly without damage to the pipe so as to leave smooth end at right angles to the axis of pipes. Pipe ends shall be properly shaped for the required joints.

The contractor shall fix all manholes, junctions, valves hydrants etc. in the positions as directed by the Engineer and shall as far as possible select the lengths of pipes to avoid cutting to waste.

All valves on rising or pumping mains shall be laid and jointed as shown in the drawings or as directed by the Engineer.

**5.13 BENDS**

Bends, tees etc. on rising mains shall be laid as shown in the drawings or as directed by the Engineer. Jointing of these specials shall be done as per requirement of pipes.

**5.14 CONCRETE THRUST BLOCKS**

Concrete thrust blocks on rising or pumping main alignment shall be constructed of CC 1:2:4 as shown on the drawing. Formwork shall be constructed where necessary to continue the concrete to the required dimensions. The thrust blocks shall be poured against undisturbed earth where possible or otherwise on compacted bed and side as per Engineer's satisfaction. These shall be provided against all bends. The concrete shall be cured for a minimum of 14 day by keeping surface wet.

**5.15 CONSTRUCTION OF MANHOLES AND VENT SHAFTS**

Contractor shall construct the manholes and vent shafts in positions as shown in drawings or where otherwise directed by the Engineer. The work of construction of manholes and vent shafts shall proceed along with the work of laying of sewer pipes. The timbering steel sheet piling and other side supports of trenches shall not be removed, dewatering for trenches shall not be stopped and backfilling of trenches over laid sewers shall not be allowed until the manholes are fully constructed at the required places, checked, tested and approved by the Engineer.

Manholes shall be constructed concurrently with the adjacent pipe lengths. The contractor shall build in pipes and for grades as directed. Short length pipes with flexible joint shall be used immediately adjacent to manholes, as detailed Benching shall be left completely smooth to the satisfaction of the Engineer.

Manholes and vent shafts shall be constructed of cast-in-situ vibrated concrete. Dimensions and mix of concrete shall be as shown in drawings. All steel section and pipe shall be painted with three coats of approved paint over primer.

All channels and benching shall be finished smooth and accurately shaped in accordance with the drawings.

Mild Steel steps shall be provided as shown in drawings. The M.S. reinforcement Bars shall conform to the requirements of Drawings and specifications.

The manhole walls shall be constructed of fair face steel form and no plaster will be required. However in case smooth surface is not attained inside and out side of manholes shall be plastered smoothly with 19 mm thick cement sand mortar of 1:3 using S.R. cement and the manhole shall be absolutely watertight. Two coats of hot bitumen at the rate of 7Kg per 10 Sq.m shall be applied on external surfaces. No extra payment shall be paid for this work.

Mild Steel sheet frame and R.C.C. covers shall be made as per drawing.

The concrete used in the manholes shall conform to the specifications given in Section – V of this Specification. The cement used shall be sulphate resisting.

Refilling around manholes shall be carried out as specified for refilling excavations.

**5.16 NEW MANHOLES ON EXISTING PIPES**

Where directed, excavation shall be made down to and around existing pipes and concrete 1:1½:3 foundations shall be formed under the existing pipe. The manhole shall be constructed thereon and the new pipe connection built-in.

The section of the existing pipe inside the new manhole shall when directed be carefully removed and new benching formed. The ends of the disused pipes shall be stopped off with concrete seals or provided with rodding eyes through the new benching.

Care shall be taken to ensure that no materials from the excavation or debris of any kind enters the pipes during the construction of manholes.

**5.17 BOLTS, NUTS, WASHERS AND FASTENINGS**

Bolts, nuts, washers, straps etc shall be of stainless steel except where otherwise specifically required. The heads and nuts of bolts shall comply with BS 4190. The ends of the bolts & nuts shall be cleanly cut with standard threads and the nuts must fit with bolts accurately and so tightly that they can just be screwed down by hand. Washers of approved shapes and sizes are to be provided when required.

Machinery and stanchions shall be held in position with stainless steel foundation bolts suitable for the purpose with a minimum embedded length of 200 mm. Rag bolts and self tapping bolts will not be acceptable in these conditions.

**5.18 PAYMENT**

Rate shall include for supplying, laying, jointing and testing for RCC pipes for each type or category of pipes, provided as per rates quoted in the BOQ. The rate shall include the cost of the pipes, rubber rings/cement solvent, sockets, collars and all other material, equipment, plant and labour required for laying, jointing and testing of pipes or sewers for a complete job. No deduction shall be made for the manholes in the measurement for the length of the pipe laid in continuation.

Payment for manholes and vent shafts shall be made for complete as per drawings and specifications.

Payment for thrust blocks if required shall be made for each thrust block of the required size and dimension as per drawings and specifications or otherwise directed by the Engineer as per item rate of concrete quoted in BOQ.

## SECTION – 6

### CONCRETE

#### 6.1 SCOPE OF WORK

The work covered by this section of the Specifications consists of furnishing of all plant, labour equipment appliances and materials and in performing all operations in connection with concrete work complete in strict accordance with the applicable drawings and the Specifications herein and subject to the terms and Condition of the Contract.

#### 6.2 GENERAL

Full cooperation shall be extended to other trades to install embedded items, and opening etc. Embedded items shall have been inspected and check tests for concrete and other materials or for mechanical operations shall have been completed and approved before concrete is placed.

#### 6.3 MATERIALS

##### 6.3.1 Cement

- i) All cement used under this Contract shall be S.R Cement.
- ii) Sulfate Resistant Cement shall be normal where required shall conform to Pakistan Standard Specification PS No. 612:1967 or BS 4027 and satisfying to requirements for fineness, chemical composition, strength, setting time and soundness etc.
- iii) The average compressive strength of three mortar cubes prepared with 1:3 cement and standard silica sand shall be not less than 155Kg/sq cm. in at three days and not less than 239 Kg/sq cm. in at seven days.
- iv) The initial setting time shall not be less than 45 minutes and final setting time not more than 10 hours.
- v) The supply of cement must be so programmed by the Contractor that at no time the quantity of cement stock shall be less than that required for an average consumption of four weeks, lorry or truck or other means of transportation, for the conveyance of cement to the site of works, shall be clean, dry, metaled lined and covered from top with water proof sheets, so that cement is sufficiently protected from any deterioration during transit. The Contractor shall provide at his own cost on the site all necessary sheds which shall be perfectly dry and water tight for the storing of cement delivered to the works to ensure adequate supplies being available for the works.
- vi) If at any time Engineer or his Representative considers that any batch of cement may have deteriorated on the site during storage for any reason, he will direct that tests shall be made and the batch of cement on the site which may be in question shall not be used until it has been shown by test at a laboratory, approved or appointed by the Engineer to be satisfactory. Contractor shall bear all costs of such testing. The Contractor without delay shall remove any rejected cement from the site. Cement reclaimed from cleaning bags or leaking containers shall not be used.
- vii) Cement shall be consumed in the sequence of receipts from factory unless otherwise directed by the Engineer or his Representative.
- viii) The total acid soluble alkali content  $\{Na_2O+0.658K_2O\}$  of cements determined in accordance with BS 4550. Part-2 shall not exceed 0.60% by weight, except where otherwise approved or required.

##### 6.3.2 Aggregates

- i) All fine and coarse aggregates to be used shall be supplied from approved sources, which shall not be changed without permission in writing from the Engineer. Aggregates shall conform to the test requirements of Pakistan Standard 243:1963 or equivalent or B.S 5882.
- ii) Fine aggregates, shall be approved sand and shall be clean, sharp, free from clay, earth, vegetable

and organic matters, alkaline or acid reactions or other deleterious matter or impurities.

- iii) Fine aggregates shall conform to Pakistan Standard Specifications PS No: 243:1963 "Natural Aggregates for Concrete" and shall be graded as follows:

<b>BS 410</b>	<b>Percentage by weight passing</b>	
	<b>Grading Zone – I</b>	<b>Grading Zone – II</b>
3 / 8" (9.5 mm)	100	100
3 / 16" (4.8 mm)	90 – 100	90 – 100
No. 7	60 – 95	75 – 100
No. 14	30 – 70	55 – 90
No. 25	15 – 34	35 – 59
No. 52	5 – 20	8 – 30
No. 100	0 – 10	0 – 10

- iv) Coarse aggregates shall be approved or hard crushed stone from a source approved by the Engineer and shall be clean, free from sand, dust, salt, lime, chalk, clay organic impurities or other deleterious matter.

- v) Coarse aggregates shall conform to the relevant Pakistan Standard Specifications PS NO. 243:1963 coarse aggregate shall be graded as follows:

FOR CONCRETE 1:1-1 / 2:3 and 1:2:4 (Nominal Size of Graded Aggregates 3 / 4" to 3 / 16" (19 mm to 4.8 mm).

<b>B.S. SIEVE NUMBER</b>	<b>PERCENTAGE BY (WEIGHT) PASSING</b>
1" (25.4 mm)	100
3 / 4" (19 mm)	90 – 100
3 / 8" (9.5 mm)	20 – 55
3 / 16" (4.8 mm)	0 – 10

FOR CONCRETE 1:3:6 or 1:4:8 (Nominal Sizes of Graded Aggregates 1-1 / 2" to 3 / 16" (38 mm to 4.8 mm)

1-1 / 2" (38 mm)	100
1" (25.4 mm)	95 – 100
3 / 4" (19 mm)	35 – 70
3 / 8" (9.5 mm)	10 – 33
3 / 16" (4.8 mm)	0 – 5

- vi) All aggregates shall be stored on properly constructed paving and in bins and there shall be a physical Partition between the stockpiles of coarse and fine aggregates. No mixed up aggregate shall be used in any concrete. Under no circumstances aggregates shall be allowed to be in contact with ground.

If required the aggregates shall be washed and screened to the satisfaction of the Engineer before use. Adequate time shall be allowed for the moisture content to become substantially uniform before use in works.

- vii) Sieve analysis and other necessary tests of all aggregates shall be carried out as and when required by the Engineer. Samples for such tests shall be taken in presence of Engineer. All costs in connection with the test shall be borne by the Contractor.

- viii) If suitable gravel meeting with the specification is not available the Contractor will arrange suitable crushed stone conforming to the specifications. No extra payment will be made to the Contractor for this aggregates or crushed stone.

- ix) Water absorption of aggregates shall not exceed 2% and mechanical strength (Measured by the Aggregate Impact Values) shall exceed 25%.

- x) Marine aggregates will not be permitted and all aggregates shall not contain applicable amounts

of flaking and or elongated particles.

- xi) The amount of dust material passing B.S. No.200 sieve (75 micron) in the combined aggregates shall not exceed 6% by weight for fine aggregates and 1% by weight for coarse aggregates.
- xii) Aggregates for granolithic concrete shall be all in granite aggregate complying with B.S 882 and be 10 mm nominal size.
- xiii) All aggregates shall be subject to the approval of the Engineer. Any aggregate not found to the required standard shall be rejected by the Engineer or his representative and shall have to be removed from LARKANA without delay. Concrete structures executed and rejected shall be dismantled and rebuilt at the Contractors expense.

### 6.3.3 Water

Water shall be free from all suspended or dissolved impurities. The water used for concrete shall be generally fit for human consumption. If required water shall be subject to standard testing at Contractor's expenses and if found unsuitable for construction the Contractor shall take suitable action as directed by the Engineer or his representative(s).

## 6.4 CONCRETE STRENGTH

The minimum compressive strength of concrete required on the basis of test cubes and minimum quantity of cement required for the concrete shall be as under:

Nominal Min. Ratio	Min. Qty. of Cement		Preliminary Cube strength				Work Cube Strength			
	Lbs. Per 100 Cft.	Kg / Cum	At 7 days		At 28 days		At 7 days		At 28 days	
			Lbs / Sq. in	N / Sq mm	Lbs / Sq. in	N / Sq. mm	Lbs / Sq. in	N / Sq. mm	Lbs / Sq. in	N / Sq. mm
1:1½:3	2520	404	3350	23.4	5000	35	2500	17.5	3750	26.2
1:2:4	2016	323	2700	18.9	4000	28	2000	14.0	3000	21.0
1:3:6	1344	216	1300	9.1	2000	14	1000	7.0	1500	10.6
1:4:8	1008	161	550	5.9	1350	9.4	650	4.5	1000	7.0

## 6.5 PROPORTIONING OF CONCRETE MIXES

All concrete shall be proportioned by Volume for design of concrete mixes, unless specifically directed by Engineer to proportion them by Weight The Contractor shall submit to the Engineer before the start of concreting proposed mix designs for concrete to be used based on laboratory tests to determine the proportion of cement, aggregates, and water in the concrete conforming to the quality and strength requirements specified. The source, and specific gravity of aggregate and name of laboratory shall be submitted along with mix design. The cost of all such testing and mix design shall be deemed to have been included in the item rates of Contractor.

### 6.4.1 Maximum Allowable Water Content

All concrete specimens shall be made, cured and tested in accordance with British Standard or ASTM Standard and Water cement ratio shall be varied to achieve the required strength and the Engineer before the start of concrete work shall be approved this ratio.

### 6.4.2 Slump Test

The slump for concrete, determined in accordance with PS 422:1964 "Slump Test for concrete" shall be minimum of 25mm (1") and a maximum of 75 mm (3") provided the required strength is obtained.

**6.6 MIXING**

Concrete shall be mixed by mechanical batching plant with adequate facilities for accurate measurements and control of each material entering the batching plant and for changing the proportions to conform to varying conditions of the work. Volumetric batching can be adopted as per engineer instruction, using cement by weight, according to the following table:

Nominal	Cement	Sand Cft.	Coarse Aggregate Cft.
1:1½:3	110 Lbs 50 Kgs	1-7 / 8	3-3 / 4
1:2:4	110 Lbs 50 Kgs	2½	5
1:3:6	110 Lbs 50 Kgs	3-3 / 4	7½
1:4:8	110 Lbs 50 Kgs	5	10

Water shall be measured for every batch with due allowance made for water already present in aggregates.

- a) Mixers shall not be charged in excess of noted capacity nor be operated in excess of noted speed. Excessive mixing shall not be permitted. The entire batch shall be discharged before re-charging.
- b) Mixing time shall be measured from the instant water is introduced into the mixer drum containing all solids. Mixing water shall be introduced before one-fourth of the mixing time has elapsed. Mixing time for mixers of one cubic meter or less shall be 2 minutes.
- c) No hand mixing shall be permitted. If during concreting, the Batching plant fails, the concrete already poured shall be removed, unless otherwise directed by the Engineer or his Representative.
- d) Test cubes of concrete shall be prepared and stored by the Contractor, in accordance with PS: 560:1965, as and when directed by the Engineer or his Representative. Test cubes be tested in laboratory and the Contractor shall bear the charges for the same.

**6.7 TRANSPORTING AND PLACING CONCRETE:**

- a) Concrete shall be conveyed and as quickly as possible after mixing and shall proceed so that, as far as possible, a complete section of the work is done in one operation. Concrete, which has attained its initial set or has contained its mixing water for more than 30 minutes shall not be allowed to be placed in the works.
- b) Transport of concrete shall be in a manner approved by the Engineer's Representative and shall be so as to avoid segregation or loss of ingredients of concrete.
- c) The Engineer's Representative shall approve all foundations and portions of work to be concreted before concrete is poured.
- d) All forms and reinforcement shall be completed, cleared inspected and approved before pouring of concrete. No concrete is to be poured till the Engineer's Representative has inspected and approved in writing all reinforcement, foundations forms, details, positioning of all fixture and materials to be embedded in concrete. The Engineer or his representative shall issue an authorization to start concrete for each day work in a form to be called pour slip. This pour slip will give the result of checking of formwork, reinforcement, and quality of aggregates, cement and mixing & vibrating equipment and date of pouring of concrete. This pour slip shall form the basis for payment to Contractor. No payment will be made for the concrete for which pour slip has not been issued by the Engineer or his representative. The Contractor shall maintain a complete record of concrete pour slips issued by the Engineer or his authorized representative. Laying of concrete shall be carried out only in presence of authorized representative of the Engineer. Dry concrete laid without the presence of Engineer's representative will not be accepted and will not be paid for.
- e) All concrete shall be thoroughly compacted and consolidated by means of Pneumatic or mechanical vibrators or other approved compacting method. Care shall be taken to avoid segregation due to excessive vibration. The Contractor shall maintain at all times one or more stand by vibrators. Tapping or other external vibration of forms shall not be allowed, unless so directed by the Engineer's Representative. Compaction shall be done until the whole mass assumes a jelly like

appearance and consistency with the water just appearing on the surface. Concrete shall be sufficiently tamped and consolidated around the steel rods, care taken that the vibrator does not touch steel or formwork and is worked into all parts of the moulds in order that no voids or cavities are left. Steel shall not be disturbed during operations of concreting. Concrete shall be brought up in even layers of about 300 mm (12") thickness or as approved by the Engineer and worked against side of forms to give a smooth and uniform surface. No surplus water shall be allowed to come out and lie on the surface of concrete. The concrete must be of such a consistency that after ramming, consolidating and tamping is completed, a thin film of water is just appearing on the surface.

- f) Hardened concrete, debris and foreign material shall be removed from interior of forms and from inner surface of mixing and conveying equipments.
- g) Runways shall be provided for wheeled concrete handling equipment, and such equipment shall not be wheeled over reinforcement, nor shall runways be supported on reinforcement.
- h) Concrete shall not be dropped freely from a height of more than 2.5 m in columns and 1.5 m (5 ft) elsewhere. In case where an excessive drop is inevitable the Contractor shall provide spouts, down pipes, chutes, or side ports to forms with pockets, which will let concrete flow easily into the form without any risk of segregation. The discharge of the spouts, down pipes or chutes shall be controlled so that the concrete may be effectively compacted into horizontal layers not more than 300 mm (12") thick.
- i) When concrete is laid on hard core, such as sub-grade for floor slabs, or other absorbent material, the surface is to be watered, consolidated and, where specified, blinded before the concrete is laid.
- j) Fresh concrete shall not be placed on previously laid concrete or on old concrete surfaces until the latter has been cleaned of dirt, scum and laitance by wire brushes. The clean surface shall then be thoroughly wetted and grouted with cement slurry as approved by the Engineer's Representative.
- k) Care shall be taken not to disturb newly placed concrete by vibrator, indirect loading or otherwise. No traffic or loading shall be allowed on the concrete until it has thoroughly set and hardened.
- l) No concrete shall be placed during rains or when the sun, heat, winds or other weather conditions prevent proper placing, finishing and curing of concrete or when the temperature is above 43 deg. C and below 35 degree F or when the concrete is likely to be subjected to freezing temperatures. All fresh concrete shall be suitably protected from rainfall and excessive heat or cold.
- m) Should any part of the exposed surface present a rough uneven or imperfect appearance when the shuttering is removed, it shall be picked out to such depth and refilled and properly re-surfaced or entirely redone as per directions of Engineer or his Representative at the cost of the Contractor.
- n) On removal of the forms and before the skin has had time to harden, all faces of the concrete inside or outside, to be kept exposed shall be rubbed over with carborundum stone, and washed with cement to remove all marks, projections, hollows or any other defect. No extra payment shall be made for this work.
- o) All exposed surfaces and lines of the concrete work are to be true and fair without cracks, bends, windings and distortions of all kinds without any extra charges by the Contractor.

## **6.8 PROTECTION AND CURING**

All exposed concrete shall be cured. Curing shall be accomplished by preventing loss of moisture, rapid temperature change and mechanical injury or injury from rain or flowing water for a period of at least ten days. Curing shall be started as soon as the concrete has hardened sufficiently for the surface not to be marked. Curing shall be done either by continuous sprinkling of water on the surface or by covering with sand, hessian, canvas or other approved fabric mats, which shall be kept continually wet. If required and so directed by the Engineer or his Representative, keeping all forms continually wet shall also cure formed surfaces with forms in position.

Minimum period of curing for any concrete shall be ten days or more as directed by the Engineer. All concrete pours and concreted structures shall be clearly marked with non-washable paints to indicate the date of placing concrete. During hot weather, curing shall be done even at night.

## 6.9 FORMWORK

### a. General

The formwork shall be inclusive of all labour, material, workmanship and alike. All form work and the Contractor thereto shall design supports and relevant drawings shall be submitted to the Engineer and his Representative for approval before the work is put in hand. Such an approval shall not relieve the contractor from all the obligations of the contract or give rise to any claim.

### b. Making Forms

The formwork for all concrete work to be cast in situ shall be made of steel or other approved material for all works. . These forms work shall be properly jointed and erected with packing material to provide watertight forms. These forms shall be properly cleaned to give a smooth finished surface and shall be rigidly formed and designed by the Contractor to the shapes and forms as per drawings in accordance with the best existing practices so as to be able to withstand, without displacement, deflection or deformation movements of any kind, the pressure of the moist concrete and all other loads.

### c. Rigid with Allowance for Camber and Bulges

It shall be fabricated and erected in position, perfect in alignment, levels and true to plumb and shape and securely braced so as to enable it to with stand all weights, live and vibrating, to be endured during placing of concrete and its subsequent hardening till the form work is struck. It shall be sufficiently rigid as not to loose its form or bulge, or deflect and to give the finished concrete the required lines, plumb, size and shape.

### d. Materials and Labour

The Contractor shall supply all materials and labour, necessary for a good and speedily erection of form work such as shuttering, planks, struts, bolts, stays gangways, boards, fillets etc. and shall do all that is essential in executing the job in a workman like manner to the satisfaction of the Engineer.

### e. Formwork not to interfere or injure work

The formwork shall be so designed and arranged as not to unduly interfere with concrete, during its placing, and easy to be removed without injuring the finished concrete. Wedges, clamps, bolts and the rods shall be used, when permitted and where practicable, in making the formwork rigid and in holding it to true position.

### f. Joints in Formwork

All joints in the formwork shall be sufficiently closed to prevent undue leakage of mortar from concrete or show any appearance of leaking mortar on concrete surface.

### g. Treatment and Inspection of Forms

All rubbish particularly chipping, shavings and sawdust etc. shall be removed from the interior of the forms, immediately before placing concrete. Forms shall be coated with approved mould oil before reinforcement is placed. Surplus oil on forms and any oil on reinforcing steel shall be removed.

### h. Removal of Shuttering

No struts or timbering which serves the purpose of supporting the shuttering or centering shall be struck and removed before the minimum periods for the main classes of work given as under:

Removal of Shuttering	Cold Weather Days	Normal Weather Days
Beams sides, walls and Columns (unloaded)	5	3
Slabs soffits (Props left under)	10	7
Removal of props to slabs	18	14
Beams soffits (Props left under)	13	10

Struts or other timbers or supports, the removal of which may cause the transference of load to the finished work, shall be kept in place for three weeks after the placing of the concrete.

**i. Injury or damage**

The Contractor shall be responsible for any injury to the work and any consequential damages caused by or arising from the removal and striking of forms, centering and supports, and any advice, permission or approval given by the Engineer or his Authorized Representative, related to the removal and striking of forms, centering and supports shall not relieve the Contractor from the responsibilities herein defined.

**j. Treatment after Removal of Forms**

Any minor surface honeycombing or other irregularities are to be properly made good immediately upon the removal of the formwork and the surface made good to the satisfaction of the Engineer and his Representative. Any small voids shall be neatly stopped with cement mortar consisting of one part of cement to two parts of sand and the whole surface rubbed over with carborundum stone and cements wash and bring the whole to a smooth and pleasing finish and uniform colour.

**k. Form work shall not be measured or paid for separately and shall be deemed to be included in the unit price of concrete whether cast-in-situ or precast and subsequently fixed in position.**

#### 6.10 CLEANING AND REMOVAL OF RUBBISH

On completion of works herein the Contractor shall remove all concrete debris, rubbish, shuttering materials, scraps etc., from the vicinity of the structures completed. All areas shall be cleaned to the satisfaction and approval of the Engineer.

#### 6.11 PLACING STEEL REINFORCEMENT ON FORM WORK

**a) Clear cover to main reinforcement in concrete members be as follows :-**

For slabs, projections, chajjas, fins, walls, staircases precast slabs.	19 mm
For beams, Columns, all members of water retaining structures on the side in contact with water.	37 mm
For foundations, retaining walls, and foundation beams.	50 mm

**b) All the reinforcing bars are to be properly placed and spaced as shown on the working drawings. Steel chairs and concrete spacer blocks are to be used without any extra cost. Concrete spacer blocks are to be properly cured to avoid their damage during concreting, thereby causing displacement of bars. Holes made by bolts etc., introduced for keeping the shuttering in act should be properly treated after striking the shuttering. No such holes shall be allowed in walls of water retaining structures and earth retaining walls.**

#### 6.12 WATERPROOF CONCRETE

All concrete work below ground level shall be executed in SR cement with water proof compound of approved type and shall be mixed in with concrete in strict accordance with the instruction of manufacturer or as directed by the Engineer.

### **6.13 FINISHING OF FORMED SURFACES**

All concrete surfaces exposed to public view or inside of sump or wet well and screening chamber shall be smooth form finish. No plastering will be allowed or paid for. The concrete surfaces not exposed to public view eg. External surfaces of sump or wet well or screening chamber shall be fairly smooth for application of water proofing treatment. Other surfaces may be rough form finish.

### **6.14 MEASUREMENT AND PAYMENT**

Payment for concrete shall be made on the basis of approved tendered rates of the Contractor for all types of concrete work carried out by the Contractor and approved by the Engineer except that no separate payment shall be made for concrete work in chambers and concrete work required for reinstatement of drains dismantled / cut for laying pipes across the drains. This shall be deemed to have included in the lump sum rate of chambers and concrete work required for reinstatement of drains dismantled / cut for laying pipes across the drains quoted by the Contractor.

No payment shall be made for the concrete work, which has been laid without the issue of pour slip by the Engineer or his representative.

## **SECTION – 7**

### **BRICK MASONRY**

#### **7.1 SCOPE OF WORK**

The work covered by this section of the specifications consists of furnishing all Plant, Labour, Equipment, Appliances, and materials and in performing all the operations in connection with brick masonry work complete in strict accordance with the specifications herein and the applicable drawings and subject to the terms and conditions of the Contract.

#### **7.2 BURNT BRICKS**

For specification of bricks refer Section II (Materials)

#### **7.3 CEMENT MORTAR FOR MASONRY**

- a) Cement mortar to be used for all brick masonry work shall be 1:4 (one part cement and 4 parts of approved fine sand).
- b) The dry materials shall be dry mixed for approximately 2 minutes and for 3 minutes after addition of water making total minimum time of 5 minutes. If mixing is not satisfactorily done, then the Contractor shall take such steps as directed by the Engineer.
- c) For dry mix, turn over materials for each batch before adding water, until uniform colour of mixed material indicates cementing material thoroughly distributed throughout the mass. After dry mixing is complete, add water thoroughly until mortar of the required plasticity is obtained.
- d) Mortars shall be used within half an hour of mixing. Mortars standing more than half an hour shall not be used.
  - i. The ingredients for mortar shall be measured in boxes. No re-tampering of mortar shall be allowed nor mixing of any anti-freezing ingredients shall be permitted.
  - ii. The thickness of Joints shall not be less than 6 mm. The overall height of 4 courses of Bricks shall not be less than 300 mm.

#### **7.4 MASONRY AND JOINTING**

- a) All bricks to be used in brickwork with mortar joint shall be immersed in water from 3 to 4 hours before these are used.
- b) No half bricks or bats shall be used except where necessary to complete the bond. At all corners alternate courses of bricks shall be laid header wise and stretcher wise, so as to bind the two walls together. All brickwork shall be truly plumb and each set of four brick courses shall be checked with plumb bob for straight edges. The Joints of brickwork which is to be pointed or plastered shall be raked out to a depth of half an inch. The raking shall be done before the mortar sets each day.
- c) All masonry shall be laid plumb, true to line and level in accurately spaced courses with each course breaking joints with the course below. Corners & reveals shall be plumb and true. Chases, grooves, reglet block and raked out joints shall be kept free from mortar and other debris.
- d) All brickwork shall be cured with water. The brickwork shall be kept wet for at least 7 days after laying.
- e) To join the brick masonry wall with RCC. or CC work proper type of dove-tail shall be used as directed and approved by the Engineer without extra payment.

#### **7.5 COORDINATION**

- a. The Contractor shall provide chases and openings required under other sections to sizes and location shown in the drawings.

- b. The Contractor will be required to ascertain all particulars relating to positions in which chases, holes mortises, conduit ducts and similar item will be required to be formed or left before the general work is put in hand and this will be deemed to be included as part of the Contractors attendance as described in the specifications for Contract under Particular Conditions.
- c. The Contractor shall operate with other trades in setting built-in-items, take special care in cutting, fitting, setting units so that built in members are in their true and respective positions.
- d. Items provided in other sections such as doorframes, hold fasts, miscellaneous metal work occurring in the masonry. Sleeves, anchors supports, nailing stripe, braces, Jamb, etc. are to be built-in the masonry.
- e. Special care shall be taken in laying bricks at doorframes. Contractor shall see that frames are square and in plumb. Brick masonry at door location shall be carried out after wooden or hollow metal doorframes are installed in plumb. The anchors are embedded in mortar Joints, filling of hollow metal doorframes with 1:2:4 concrete shall be done along with masonry work.
- f. The Contractor shall be responsible for any damage to his own work, and also to the work of other sections.

#### **7.6 SAMPLES**

Samples of all bricks & other materials to be used under this section shall be submitted to the Engineer for his approval.

#### **7.7 TESTING**

All the brick samples and materials shall be subject to standard testing and if found below the recognized standard specifications such as BS, ASTM or equal shall be rejected. Rejected material shall be removed from the site immediately. All testing shall be done at Contractor's cost from laboratory approved by the Engineer.

#### **7.8 MEASUREMENT AND PAYMENT**

##### **A. Measurement**

Measurement for payment for brickwork will be made for actual front face of brick work. No measurement of Jamb sills etc. shall be made.

##### **B. Payment**

Payment for brick work will be made as per the unit rate in the Bill of Quantities for actual work executed. The unit rate tendered for such work shall include the cost of bricks, mortar and placing curing and all other operations, procedures and requirements necessary to complete the brick work in accordance with this specification.

## SECTION – 8

### REINFORCEMENT STEEL

#### 8.1 SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all materials, tools labors and in performing all operations in connection with the providing, straightening cutting, bending, binding, fixing including binding wire, chairs, pins, spacer block complete in strict accordance with this section of the Specifications, the applicable drawings, approved bar bending schedule, and the terms and conditions of the Contract.

#### 8.2 MATERIALS

Reinforcing steel shall be new billet stock of mild steel (Plain bar) hard grade (deformed bar) and Ribbed Tor Steel as specified on the drawings and shall be obtained from the approved manufacturer and shall conform to British Standard Specifications or equivalent ASTM or Pakistan Standard. It should comply with BS. 4360 and be of No. 1 quality.

The Contractor, if required shall furnish to Engineer's Representative Manufacturers mills certificates to guarantee that steel meets the standard, specifications, requirements and minimum certified yield stresses as follows:-

Mild steel plain bars conforming to B.S.S. 4449 or PS-231- 1962, Hard graded deformed bars conforming to PS-605-1966 and rubbed for steel conforming to BS-4461.

Tensile Strength :- 438 to 517N / mm(28to33 tons / sq.in).

Yield strength :- 250 N / mm<sup>2</sup> (16 Tons / sq / .in).

Elongation :- 16% to 24% (av. - 20%).

Hard grade deformed bars conforming to PS-605-1966.

Tensile strength :- 560 N / mm<sup>2</sup> (35.7 Tons / sq in).

Yield strength :- 350 N / mm<sup>2</sup> (22.3 Tons / sq.in).

Elongation :- 1100 000 x % \_\_\_\_\_ Tensile strength

Ribbed Tor steel conforming to B.S. 4461.

Tensile strength :- 490 N / mm<sup>2</sup> (70,000 lbs / sq.in).

Yield strength :- 420 N / mm<sup>2</sup> (60,000 lb / sq.in).

Elongation :- 14.5 %

All steel to be true to the Standard Specifications with regard to bendability specially the hard grade deformed bars under 19mm (3 / 4") shall be capable of being bent cold through 90 degree round a bars of four times its own diameter without fractures or injury of any kind. In case of deformed bars over 19m.m (3 / 4") and above, round bar of 6 times its own diameter.

18 gauge-galvanized wire shall be used for binding the steel reinforcement.

Samples shall be tested for above specification in an approved Laboratory when required by the Engineer or his Representative and all costs of such tests shall be borne by the Contractor. Samples shall be taken from the stocks brought by the Contractor. All under gauge bars shall be rejected. Engineer may allow use of over gauge bars on the condition that only standard weight shall be allowed for such steel bars.

Steel bars for reinforcement of concrete shall comply with the requirements of B.S.4461 for cold worked steel bars Grade 460 / 425 and BS.4449 for hot rolled steel bars Grade 250.

### **8.3 STORAGE**

Reinforcing bars shall be stored on platforms above surface of ground and be free from scales, oil, structural defects prior to placement in works. Rusted or dirty steel bars shall not be used in the works unless brushed and cleaned by proper steel wire brushes and after being approved for use by the Engineer.

### **8.4 REINFORCEMENT CUTTING AND PLACING**

All reinforcement steel shall be cut and bent cold in strict accordance with bar bending schedules approved and drawings supplied by the Engineer. The Contractor shall prepare bar bending schedule from approved structural working drawings and instructions to be provided to him by the Engineer. The bending schedules shall be drawn on approved forms and submitted to the Engineer or his Representative for checking and approval. The steel reinforcement shall be cut and bent to sizes as per drawings and approved bending schedules. In case any bars, cut, bent or even fixed in position are found incorrect in dimensions size or shape according to the requirements of the drawings and instructions of Engineer, the Contractors shall replace such steel bars cut bent or fixed in position by correct sized bars at his own cost and no extra payment shall be made to the Contractor on such account. The system of holding bars in place shall ensure that all steel in top section will support weight of workmen without displacement or distortion. Suitable spacers chairs as approved by the Engineer Representative shall be used for supporting and spacing purposes of bars. In case any bars are bent or displaced they shall be straightened or replaced prior to pouring.

### **8.5 LAPS AND SPLICES**

No splicing of bars shall be allowed at position other than shown on the drawings. All lap lengths shall be of the minimum sizes as indicated on the drawings and in no case shall lap length be less than 40 times the diameter for bars in tension and 35 times the diameter for bars in compression for nominal M.S. bars. Hard grade bars and tor steel shall have laps of 50 time the bigger diameter of lapping bars. Splices of adjacent bars shall be staggered unless approved otherwise by the Engineer or his Representative.

The Engineer Representative shall inspect all reinforcing steel fixed in position and no concrete shall be poured until the Engineer's representative has approved steel placement. For inspection purposes the Contractor shall give to the Engineer Representative reasonable notice before the scheduled pouring time. Clear concrete cover to reinforcement steel shall be as indicated specified.

### **8.6 MEASUREMENT AND PAYMENT**

Payment for steel reinforcement shall be made on the basis of approved tendered rate for all steel supplied, cut, bend and binded by the Contractor as required and as determined from the approved bar bending diagrams and incorporated in the concrete and checked and accepted except that no separate payment of steel reinforcement will be made for chambers and reinstate work for drains cut for laying pipeline. This will be deemed to have been included in the lump sump rate of chambers and reinstate work for drains cut for laying pipeline quoted by the Contractor. The weight of plain or deformed bars will be computed from the theoretical standard weight of M.S. bars, in case of over size bars. If the Engineer allows the use of undersized bars only within allowable tolerance of weight the Contractor shall be paid on the basis of actual weight of bars supplied.

No separate payment shall be made for the spacers, binding wire and chairs etc. not included in the bending schedule.

## SECTION-9

### COMBINED EFFLUENT TREATMENT PLANT

#### 9.1 DESIGN BASIS

Untreated Effluent Nature	: Sewage Wastewater
Operating Hours Per Day	: 24
Ultimate Plant Capacity	: 100,000 Gallons/Day

#### 9.2 TREATMENT OBJECTIVE

The objective of wastewater treatment shall be to bring the significance of discharge effluent inline with the EPA Pakistan NEQS or receiving water body and also to ensure this treatment as an environmental friendly.

#### 9.3 TREATMENT CONCEPT

Screening, Pumping of untreated effluent, Grit removal, Oil & grease removal (Primary Treatment) flow distribution of ultimate stream followed Biodegradation by Activated Sludge process and clarification (Secondary Treatment).

##### 9.3.1 UNTREATED EFFLUENT CHARACTERISTICS / TREATED EFFLUENT QUALITY

The minimum effluent characteristics are as follows:

The contractor / manufacturer shall follows the NEQ'S characteristics of all the parameters.

Parameters	Untreated Effluent Test Results	Treated Effluent Results	NEQS
PH	7-8	6 ~ 9	6 ~ 9
BOD5	350 mg/l	80 mg/l	80 mg/l
COD	800 mg/l	150 mg/l	150 mg/l
TDS	860 mg/l	3500 mg/l	3500 mg/l
TSS	400 mg/l	< 200 mg/l	< 200 mg/l

##### 9.3.2 POLLUTION LOAD

Ratio of COD/BOD	: 2.2
BOD5 Load	: 479 kg/day (Unit Phase)

##### 9.3.3 DESIGN STATEMENT

- The proposed Treatment System will not reduce untreated Effluent TDS concentration.
- The STP shall be executed in one phases, shall be providing treatment for 100% (ultimate flow 400,000 GPD).
- Untreated Effluent temperature should be less than 40 OC.

#### 9.4 PROCESS DESCRIPTION

##### 9.4.1 SCREEN CHAMBER

Untreated effluent shall enter into a screen chamber, provided at the inlet of the plant. A common screen chamber shall be of rectangular geometry in plan and shall be constructed in RCC for ultimate capacity of plant (400,000 GPD). The untreated effluent shall be received through gravity sewer in common influent chamber, provide at the start of the screen chamber, which shall be connected to 2 parallel downstream screening compartments (one of the compartment is operational while other is standby) through manually – operated sluice

gate in order to bring any one of screening compartments out of operation, for cleaning or maintenance purpose.

Both the screening compartments shall be provided with separate replaceable epoxy-coated mild steel (MS) manually-cleaned bar screens.

#### **9.4.2 WET-WELL**

The untreated effluent from the common effluent chamber of screen chamber shall discharge directly into the wet well / receiving pit. A common wet well / receiving pit shall be constructed for ultimate plant capacity (400,000 GPD).

#### **9.4.3 PUMPING STATION**

The dry well shall be constructed underground and of rectangular in geometry. Horizontal, centrifugal, non – clogging type wastewater pumps will be installed in the dry well. Ultimate provision of raw wastewater pumps is 04 Nos. (03 duty +01 Standby) of equal discharge capacity.

#### **9.4.4 GRIT REMOVAL CHAMBER**

The pumped wastewater shall pass through grit chamber prior to entering the pre-selector of the aeration tank. Grit removal is essential to avoid overloading of the aeration tank with inert inorganic material. A common grit chamber shall be constructed for ultimate plant capacity. The grit chamber will be raised above the finished grade level to allow gravity flow to the Flow distribution chamber. This raising would also permit the discharge of the grit collected at the bottom of the chamber, under gravity. The grit is collected in sump and disposed on periodic basis manually to avoid any odor.

#### **9.4.5 FLOW DISTRIBUTION CHAMBER**

Overflow from grit removal chamber shall be received into an inflow box of the Flow Distribution Chamber through a gravity transmission pipeline. From inflow box the wastewater shall flow, in equally-split streams, to three separate outflow boxes, over .3 sharp-crested rectangular weirs (Stainless Steel), of equal size and same sill levels, installed on walls between inflow box and outflow boxes. The Inflow box shall be provided with appropriate baffle walls in order to minimize the agitation due to the incoming wastewater stream.

#### **9.4.6 PRE – SELECTOR TANK**

From the base of each Outflow Box of Flow Distribution Chamber, a vertical outflow pipe with a gate valve, shall be taken and connected to a separate underground gravity transmission pipeline, which shall carry wastewater to the Influent Wastewater Chamber of the respective Pre-selector Tank of Aeration Tank.

In Pre-selector Tanks, the incoming wastewater shall be mixed with the recycled secondary sludge from respective Secondary Settling Tanks under anoxic conditions to promote the growth of floc-forming bacteria and inhibit the growth of the filamentous bacteria, in order to provide an activated sludge with better settling and thickening characteristics.

#### **9.4.7 AERATION TANK**

The screened and grit free wastewater shall be received in Aeration Tank for biochemical degradation of dissolved and colloidal organic contaminants by aerobic biomass through extended aeration process. The untreated effluent is aerated by Diffused – Air Aeration system in Aeration Tank. The Diffused – Air Aeration System consist of diffusers submerged in

sewage water, blowers and appurtenances through which the air passes in Aeration Tank, bacteria and other micro-organisms consume biodegradable organic contaminants and bind much of the less soluble fractions into floc.

#### **9.4.8 SECONDARY CLARIFIER**

The biodegraded over flow shall be let through a clarifier for separation of bio-sludge. The mechanical sludge scrapper shall be installed in the Secondary Settling Tank for continuously scraping and directing sludge, settled at the tank bottoms, towards the Central Sludge Collection Pit. The sludge will be back to the Aeration Tank to maintain quantity of biomass (MLSS) and a part of sludge collected at the bottom of clarifier and excess sludge will be discharged to the sludge holding tank.

#### **9.4.9 SUPERNATANT SUMP**

The clarified effluent is disinfected in supernatant sum by dosing Sodium hypo chlorite. The purpose of chemical disinfection of the treated effluent is to remove pathogenic & other disease causing organisms. Treated water shall be reused / recycled for gardening purpose.

#### **9.4.10 SLUDGE HOLDING TANK**

Sludge from the secondary clarifiers shall be collected in sludge sump from where it will be pumped to sludge handling system. Two number of sludge holding tanks of equal size will be constructed in RCC for ultimate provision. The purpose of sludge tank to collect the excess sludge from secondary clarifiers and transfer the even flow to sludge thickener.

### **9.5 SLUDGE TREATMENT FACILITY**

#### **9.5.1 SLUDGE THICKNER**

Sludge from secondary clarifier will be subjected to thickening before it can be mechanically dewatered. Ultimate provision is 01 No. sludge thickeners of equal size. One sludge thickener shall be constructed for one phases. The purpose of the sludge thickener is to thicken and increase the solids concentration of the waste secondary sludge, prior to its mechanical dewatering.

#### **9.5.2 SLUDGE CONDITIONING & DEWATERING**

2– 3 % Sludge with solids concentration shall be pumped to the dewatering unit. The sludge will be conditioned by the addition of polyelectrolyte to improve dewatering characteristics. Belt filter press will be provided for sludge dewatering. The filtrate shall be discharged back to the start of the process stream, i – e of wet well for re-treatment. The dewatered sludge may be disposed to the landfill.

#### **9.5.3 AIR SUPPLY SYSTEM & MCC ROOM**

Air blowers will be installed in a blower room near the aeration tank. These air blowers will be operated as per air requirements according to wastewater characteristics. MCC of the plant will also be located in the same room. Blower room & MCC shall be constructed for Ultimate plant.

### **9.6 SALIENT FEATURES**

- User-friendly system with no need to monitor routine process
- Parameters, as in conventional systems.
- Skilled operator with due training can operate the system.

- Standby drives for smooth uninterrupted functioning of the plant.
- Lesser area requirement and modular in design.
- Ease in expansion.
- No odor, noise, nuisance & no vector attraction.
- Low O & M cost. (operation and maintenance cost)
- Facilitates quick shutdowns.

## 9.7 CIVIL WORKS

Contractor will provide the detail drawings of civil, electrical, mechanical and architectural works associated with wastewater treatment plant for wetting and approval. The structural design, drawing and execution of all civil, electrical, and mechanical works execution will be in the contractor's scope.

**NOTE:** \*Approx. effective volumes of the tanks are given. The contractor / manufacturer submit the details are as follows for negotiations and approval.

### 9.7.1 SCREEN CHAMBER (ULTIMATE FLOW)

No. of Units : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : RCC  
 Volume (L x W x D) : .....(To be filled by contractor/Manufacturer )

### 9.7.2 WET WELL (ULTIMATE FLOW)

No. of Units : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : RCC  
 Diameter : .....(To be filled by contractor/Manufacturer)

### 9.7.3 PUMPING STATION (ULTIMATE FLOW)

No. of Units : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : RCC  
 Volume (L x W x D) : .....(To be filled by contractor/Manufacturer)

### 9.7.4 GRIT REMOVAL CHAMBER (ULTIMATE FLOW)

No. of Units : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : RCC  
 Volume (L x W x D) : .....(To be filled by contractor/Manufacturer)

### 9.7.5 FLOW DISTRIBUTION CHAMBER (ULTIMATE FLOW)

No. of Units : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : RCC  
 Volume (L x W x D) : .....(To be filled by contractor/Manufacturer)

### 9.7.6 PRE- SELECTOR ((ULTIMATE FLOW)

No. of Units : .....(No.To be filled by contractor/Manufacturer)..  
 Material of construction : RCC  
 Volume (L x W x D) : .....(To be filled by contractor/Manufacturer)

### 9.7.7 AERATION TANK ((ULTIMATE FLOW)

No. of Units : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : RCC  
 Volume (L x W x D) : .....(To be filled by contractor/Manufacturer)

**9.7.8 SECONDARY CLARIFIER (ULTIMATE FLOW)**

No. of Units : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : RCC  
 Diameter : .....(To be filled by contractor/Manufacturer)

**9.7.9 SUPERNATENT SUMP (ULTIMATE FLOW)**

No. of Units : .....(To be filled by contractor/Manufacturer)  
 Material of construction : RCC  
 Volume (L x W x D) : .....(To be filled by contractor/Manufacturer)

**9.7.10 SLUDGE HOLDING TANK (ULTIMATE FLOW)**

No. of Units : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : RCC  
 Volume (L x W x D) : .....(To be filled by contractor/Manufacturer)

**9.7.11 SECONDARY THICKNER (ULTIMATE FLOW)**

No. of Units : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : RCC  
 Diameter : .....(To be filled by contractor/Manufacturer)

**9.7.12 FONDATION FOR SLUDGE FILTER PRESS (ULTIMATE FLOW)**

No. of Units : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : RCC  
 Area (L x W) : .....(To be filled by contractor/Manufacturer)

**9.7.13 MCC/ BLOWERS ROOM (ULTIMATE FLOW)**

No. of Unit : .....(No.To be filled by contractor/Manufacturer).  
 Material of Construction : Adjusted in BM / RCC/ FBG  
 Area (L x W) : .....(To be filled by contractor/Manufacturer)

**9.7.14 FOUNDATIONS FOR MECHANICAL UNITS**

No. of Units : As Required

**9.7.15 LADDERS, WALKWAYS, STAIRCASES, PLATFORMS**

No. of Unit : As Required

**9.8 MECHANICAL AND ELECTRICAL WORKS**

Contractor will provided, installation and commissioning the local and imported equipment(s) of the plant.

**9.8.1 BAR SCREEN**

Quantity : .....(No.To be filled by contractor/Manufacturer).  
 Material of Construction : SS.  
 Make : .....(To be filled by contractor/Manufacturer)

**9.8.2 GATE VALVES / SLUICE GATE**

Quantity : .....(No.To be filled by contractor/Manufacturer).  
 Material of Construction : .....(To be filled by contractor/Manufacturer).  
 Make /Origin : .....(No.To be filled by contractor/Manufacturer).

**9.8.3 EFFLUENT TRANSFER PUMPS (ULTIMATE FLOW)**

Quantity : .....(No.To be filled by contractor/Manufacturer).  
 Type : .....(To be filled by contractor/Manufacturer).  
 Capacity : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

**DRIVE**

Type : .....(To be filled by contractor/Manufacturer).  
 Protection : .....(To be filled by contractor/Manufacturer).  
 Power : .....(To be filled by contractor/Manufacturer).

**9.8.4 MIXER IN PRE – SELECTOR TANK**

Quantity : .....(No.To be filled by contractor/Manufacturer).  
 Type : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).  
 Power : .....(To be filled by contractor/Manufacturer).

**9.8.5 AIR BLOWERS (ULTIMATE FLOW)**

Quantity : .....(No.To be filled by contractor/Manufacturer).  
 Type : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).  
 Origin : .....(To be filled by contractor/Manufacturer).

**DRIVE**

Type : .....(To be filled by contractor/Manufacturer).  
 Protection : .....(To be filled by contractor/Manufacturer).  
 Power : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

**9.9 AERATION TANKS INTERNALS**

**9.9.1 AIR HEADER**

Quantity : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : SS-304  
 Make : .....(To be filled by contractor/Manufacturer).

**9.9.2 DROP PIPES**

Quantity : .....(To be filled by contractor/Manufacturer).  
 Material of construction : SS-304  
 Make : .....(To be filled by contractor/Manufacturer).

**9.9.3 VALVES**

Quantity : .....(To be filled by contractor/Manufacturer).  
 Type : .....(To be filled by contractor/Manufacturer).  
 Material of construction : .....(To be filled by contractor/Manufacturer).

**9.9.4 AIR DIFFUSERS**

Quantity : .....(To be filled by contractor/Manufacturer).  
 Material of construction : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

**9.10 SECONDARY CLARIFIER INTERNALS (ULTIMATE FLOW)**

**9.10.1 SCRAPPING MECHANISM**

Quantity : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : MS  
 Protection : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

**9.10.2 GEARED DRIVE MOTOR**

Quantity : .....(No.To be filled by contractor/Manufacturer)..  
 Type : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

**9.10.3 SLUDGE RE-CIRCULATION PUMP**

Quantity : .....(No.To be filled by contractor/Manufacturer).  
 Type : .....(To be filled by contractor/Manufacturer).  
 Capacity : .....(To be filled by contractor/Manufacturer).  
 Material of Construction : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

**DRIVE**

Type : .....(To be filled by contractor/Manufacturer).  
 Protection : .....(To be filled by contractor/Manufacturer).  
 Power : .....(To be filled by contractor/Manufacturer).

**9.11 SLUDGE HANDLING SYSTEM****9.11.1 SLUDGE TRANSFER PUMP TO SLUDE THICKENER**

Quantity : .....(No.To be filled by contractor/Manufacturer).  
 Type : .....(To be filled by contractor/Manufacturer).  
 Capacity : .....(To be filled by contractor/Manufacturer).  
 Material of Construction : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

**DRIVE**

Type : .....(To be filled by contractor/Manufacturer).  
 Protection : .....(To be filled by contractor/Manufacturer).  
 Power : .....(To be filled by contractor/Manufacturer).

**9.11.2 SLUDGE THICKENER INTERNALS SCRAPPING MECHANISM**

Quantity : .....(No.To be filled by contractor/Manufacturer).  
 Material of construction : MS  
 Protection : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

**GEARED DRIVE MOTOR**

Quantity : .....(To be filled by contractor/Manufacturer).  
 Type : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

**9.11.3 FILTER PRESS FEED PUMP**

Quantity : .....(No.To be filled by contractor/Manufacturer).  
 Type : .....(To be filled by contractor/Manufacturer).

Capacity	: .....(To be filled by contractor/Manufacturer).
Material of Construction	: .....(To be filled by contractor/Manufacturer).
Make	: .....(To be filled by contractor/Manufacturer).
<b>DRIVE</b>	
Type	: .....(To be filled by contractor/Manufacturer).
Protection	: .....(To be filled by contractor/Manufacturer).
Power	: .....(To be filled by contractor/Manufacturer).
Make	: .....(To be filled by contractor/Manufacturer).
Origin	: .....(To be filled by contractor/Manufacturer).
<b>9.11.4 BELT FILTER PRESS</b>	
Quantity	: .....(No.To be filled by contractor/Manufacturer).
Main Body Material	: SS 304
Belt Size	: .....(To be filled by contractor/Manufacturer).
Belt Material	: .....(To be filled by contractor/Manufacturer).
Cake thickness	: .....(To be filled by contractor/Manufacturer).
Main Machine Power	: .....(To be filled by contractor/Manufacturer).
Make	: .....(To be filled by contractor/Manufacturer).
Origin	: .....(To be filled by contractor/Manufacturer).
<b>9.11.5 WASHING PUMPS</b>	
Quantity	: .....(No.To be filled by contractor/Manufacturer).
Type	: .....(To be filled by contractor/Manufacturer).
Capacity	: .....(To be filled by contractor/Manufacturer).
Material of Construction	: .....(To be filled by contractor/Manufacturer).
Make	: .....(To be filled by contractor/Manufacturer).
<b>DRIVE</b>	
Type	: .....(To be filled by contractor/Manufacturer).
Protection	: .....(To be filled by contractor/Manufacturer).
Power	: .....(To be filled by contractor/Manufacturer).
Make	: .....(To be filled by contractor/Manufacturer).
Origin	: .....(To be filled by contractor/Manufacturer).
<b>9.11.6 CHEMICAL DOSING PUMP</b>	
Quantity	: .....(No.To be filled by contractor/Manufacturer).
Type	: .....(To be filled by contractor/Manufacturer).
Capacity	: .....(To be filled by contractor/Manufacturer).
Material of Construction	: .....(To be filled by contractor/Manufacturer).
Make	: .....(To be filled by contractor/Manufacturer).
<b>9.11.7 AIR COMPRESSOR</b>	
Quantity	: .....(To be filled by contractor/Manufacturer).
Tank Capacity	: .....(To be filled by contractor/Manufacturer).
Pressure Rate	: .....(To be filled by contractor/Manufacturer).
Make	: .....(To be filled by contractor/Manufacturer).
<b>9.12 INSTRUMENTATION (ULTIMATE FLOW)</b>	
<b>9.12.1 SHARP CRESTED RECTANGULAR WEIR</b>	

Quantity : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).  
 Location : .....(To be filled by contractor/Manufacturer).

#### 9.12.2 FLOW METER

Quantity : .....(To be filled by contractor/Manufacturer).  
 Type : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

#### 9.12.3 LEVEL CONTROL SWITCH

Quantity : .....(To be filled by contractor/Manufacturer).  
 Location : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

#### 9.12.4 DO METER

Quantity : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

### 9.13 PIPING & VALVING

#### 9.13.1 PIPES (INTERCONNECTING WITHIN BATTERY LIMIT)

Quantity : .....(To be filled by contractor/Manufacturer).  
 Material of construction : MS  
 Make : .....(To be filled by contractor/Manufacturer).

#### 9.13.2 VALVES

Quantity : .....(To be filled by contractor/Manufacturer).  
 Type : .....(To be filled by contractor/Manufacturer).  
 Material of construction : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

### 9.14 ELECTRICAL COMPONENTS (ULTIMATE FLOW)

#### 9.14.1 MOTOR CONTROL CENTER

Quantity : .....(To be filled by contractor/Manufacturer).  
 Type : .....(To be filled by contractor/Manufacturer).  
 Main Components : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

#### 9.14.2 CABLING

Quantity : .....(To be filled by contractor/Manufacturer).  
 Make : .....(To be filled by contractor/Manufacturer).

### 9.15 MODIFICATIONS IN THE SPECIFICATIONS

Specifications and drawings submitted by the contractor and shall be vet by the consultant.

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**9.16 ENGINEERING SUBMITTAL**

**9.16.1 DRAWINGS APPROVAL**

The contractor shall submit all the detail drawings of structure, civil, architectural, mechanical, electrical including all specifications for the approval by the vetting consultant.

**9.16.2 OPERATION AND MAINTENANCE MANUAL**

Contractor will submit 01 No hard copy of operation and maintenance manual of the plant which will include the following documents:

- Operation & Maintenance Manual
- Operation & Maintenance Manual will include the following:
- Equipment Specification
- Start Up & Shut Down Procedure
- P&I Diagram
- Layout Drawing
- GA Drawings
- Piping Isometrics
- As Built Drawings
- Major Equipment Literature
- Standard Warranty Conditions of Manufacturer Supplied Equipment

**9.16.3 TRAINING OF OPERATIONS**

Contractor will provide one week on job training to operators who will be involved in starting from the installation, pre commissioning and commissioning of the plants. Necessary training in classroom will also be extended for one day.

**9.16.4 INSPECTION AND TESTING**

Following inspection and test procedure will be adopted for the project by the contractor/manufacturer:

- 1) Hydro-test Report
- 2) Dimensional Check Report,
- 3) Intermediate / Stage Inspection, if required by the client
- 4) Pre-shipment Inspection, if required by the client

## **SECTION – 10**

### **PAINTING AND FINISHING**

#### **10.1 SCOPE OF WORK**

The work covered by this section of the specifications consists of furnishing all materials, plant, labour, equipment, appliances and performing all operations in connection with surface preparation and painting works, gates, frames, steel and wooden doors, windows, louvers, walls, ceilings and all such surfaces as shown on the Drawings and / or as directed by the Engineer. The scope of this section of specifications is covered with and detailed specifications laid down herein.

#### **10.2 GENERAL**

Except as otherwise specified, all painting shall be applied in conformity with BS CP 231 "Painting of Building as applicable to the work".

The Contractor shall repair at his own expense all damaged or defective areas of shop-painted metal work. Metal surfaces against which concrete are to be placed will be furnished shop-painted and shall be cleaned prior to being embedded in concrete.

Except as otherwise specified, all concrete and plastered surfaces are to be painted.

#### **10.3 MATERIALS**

All materials shall be acceptable, proven top-grade products and shall meet or exceed the minimum standards of reputable manufacturers as approved by the Engineer.

Colours shall be pure, non-fading pigments, mildew-proof, sun-proof, finely ground in approved medium. Colours used on plaster and concrete surfaces shall be lime-proof. All materials shall be subject to Engineer's approval.

All emulsion paints and primers for metal work and walls will be the best available of its type. The make and shade shall be got approved by the Engineer prior to its procurement.

Approved quality of cement wash paint shall be used for painting the exteriors of the structures or other surfaces as directed by the Engineer.

The plastic emulsion paint or similar as approved by the Engineer shall be used for interior surfaces. Un-slaked lime, gum and marine blue shall be used for white washing.

All material for bitumen painting shall consist of Bitumen P B4 Grade 10 / 20. It shall be used for foundation or wherever recommended by the Engineer.

Approved quality, Epilac enamel paint shall be used for chemicals and water resistance where specified.

DUROCEM a cement base heavy-duty waterproof coating manufactured by ICI or any equivalent approved by the Engineer shall be used for painting on the surface specified. The cement base waterproof coating for concrete shall conform to ASTM C-109, C-67, D-822 and G-23.

All materials shall be delivered to site in their original unbroken and scaled containers or packages and bear the manufacturer's name, label, brand and formula and shall be mixed and applied in accordance with directions of the manufacturer.

#### **10.4 SURFACE PREPARATION**

All oil, grease, dirt, dust, loose mill, scales and any other foreign substance shall be removed from the surface to be painted, polished and white washed by the use of a solvent and clean wiping material. Following the solvent cleaning, the surfaces shall be cleaned by scraping, chipping, wire brushing or other effective means as approved by the Engineer.

In the event the surface becomes otherwise contaminated in the interval between cleaning and

painting, re-cleaning will be done by the Contractor at no additional cost.

Surfaces of stainless steel, aluminium, bronze and machined surfaces adjacent to metal work being cleaned or painted shall be protected by effective masking or other suitable means, during the cleaning and painting operations.

All the surfaces to be painted with approved quality cement wash paints shall be free from dust, dirt, fungus, lichen, algae etc. Oil paint, varnish and lime wash should always be removed by scrapping and washing.

All surfaces to be bitumen painted shall be thoroughly cleaned of any accretion, dust, dirt etc. by scraping wire, brushing or as directed by the Engineer. The surface shall be primed with a coat of asphalt oil used at the rate of not less than 1 litre per 2 square meter.

No work in this Section shall be allowed until all surfaces or conditions have been inspected and approved by the Engineer or his representative.

All damaged portions of surfaces shall be repaired and all other adjustments carried out before the start of painting or finishing. No addition or alteration on surface shall be allowed after the painting and finishing work is done.

## **10.5 APPLICATION**

All paint and coating materials shall be in a thoroughly mixed condition at the time of application. All work shall be done in a workmanlike manner, leaving the finished surface free from drips, ridges, waves, laps and brush marks. All paints shall be applied under dry and dust free conditions. Unless approved by the Engineer paint shall not be applied when the temperature of the metal or of the surrounding air is below 10 Degree Centigrade. Surfaces shall be free from moisture at the time of painting.

All primary paint shall be applied by brushing. The first coat of paint shall be applied immediately after cleaning. When paint is applied by spraying, suitable measures shall be taken to prevent segregation of the paint in the container during painting operations.

Effective means shall be adopted for removing all free oil and moisture from the air supply lines of the spraying equipment.

Each coat of paint shall be allowed to dry or harden thoroughly before the succeeding coat is applied. Surfaces to be painted that will be inaccessible after Installation shall be completely painted prior to Installation.

Two coats of cement wash shall be applied in accordance with the manufacturer's instructions or as directed by the Engineer.

Only as much material should be mixed as can be used in one hour. Over-thinning will not be permitted. After the first coat the surfaces will be soaked evenly four or five times and the second coat shall be applied after leaving for at least overnight.

All steel doors, windows and ventilators shall be painted with two coats of approved enamel paint over one coat of a red oxide primer as directed by the Engineer. Two coats of bituminous paint shall be provided on the external side of walls of manholes and under sides of the manhole covers.

Plastic emulsion paint of the approved make and shade shall be applied to interior surfaces required as per finishing schedule and as per manufacturer's instructions.

Epilac enamel paint of the approved make and shade shall be applied to surfaces required as per finishing schedule and as per instructions of the manufacturer.

For bitumen paint to be applied, the first coat shall be allowed to dry for about 6 hours before applying the second coat. During the operation of painting care should be taken to avoid air bubbles. The manufacturer's instruction and Engineer's directions shall be adhered to.

For applying Durocem the surface shall be dampened with clean water immediately ahead of

application. Durocem and clean water shall be mixed as per directions of the manufacturer. A heavy first coat at 20 lbs / 100 sft. (1 kg per sq.m) shall be applied. This shall be followed by a second brush coat at 10 lbs / 100 sft. (0.5 kg per sq.m) after the first coat has set. When finish coat has set, it shall be floated to uniform texture with a sponge float. The work shall include cleaning the surface, sand papering and smooth finishing, scaffolding, curing etc. complete as per the approval of the Engineer.

#### **10.6 WHITE AND COLOUR WASHING**

The surfaces shall be well cleaned and brushed before white washing. The white washing material shall be prepared from un-slaked lime. The lime shall be dissolved in a tub with sufficient quantity of water and then well mixed and strained through a clean cloth. 4 kg clean gum boiled with 12 kg of rice for each cu.m of lime shall be added to the liquid lime along with a small quantity of marine blue as directed by the Engineer.

The mixture shall be in thoroughly mixed condition in suitable consistency and suitable screened and shall be applied in three coats with a brush.

Each coat of white wash shall be allowed to dry, so that no sign of cracking shall appear on the surface and also white wash shall not come off readily on fingers when rubbed. The white wash when completed, shall form an opaque coat of uniform white colour, through which the old work does not show and shall present a smooth regular surface free from powdery matter. For colour washing approved quality of colouring matter shall be added to the liquid and thoroughly mixed by stirring.

#### **10.7 DISTEMPERING**

Distempers of approved quality and shade shall be applied on internal wall surfaces where shown in drawing or directed by the Engineer.

#### **10.8 SUBMITTALS**

Colour samples shall be submitted on 6"x 6" (150x150 mm) asbestos cement boards, showing each type of paint for Engineer's colour selections.

#### **10.9 PRODUCT DELIVERY**

Deliver materials in manufacturer's original unopened containers with labels intact and legible identifying brand names and contents.

#### **10.10 JOB CONDITION**

Observe manufacturer's recommended minimum and maximum temperature but do not apply paint or finish to any surface unless ambient temperature is 10 degree C or above and less than 43 degree C. No painting shall be done above 90% relative humidity.

Place drop cloths to adequately protect all finished work.

Remove and replace all items of finished hardware, device plates, and accessories including fixtures or other removable items.

The surface shall be prepared first by filling depressions with putty, rubbing, sand papering and cleaning. A priming coat shall first be applied of petrifying liquid of approved manufacture. Distemper shall be applied with broad stiff brush of approved make. Distemper shall be applied quickly and boldly. Each coat of distemper should first be got approved by the Engineer before applying the next coat.

#### **10.11 MEASUREMENT AND PAYMENT**

Measurement of the work completed, accepted and specified herein as painting, distempering, bitumen painting and white / colour washing etc. will be made on the basis of actual area in square meter of the respective job including all preparatory work like scraping, scratching, sand papering, filling depressions with putty, priming and scaffolding etc. complete in all respect as directed by the Engineer. Payment for these items shall be made at the approved tendered

rates. All payments shall be made for painting work on doors, windows, ventilators, steel grills, railings and steel ladders or any other works etc for which the contractor shall make necessary allowance in his rates for such items as per the BOQ.

No separate payment shall be made for the painting work required for manholes and ventilating shaft. The Contractor shall include the cost of painting work required for manholes and ventilation shaft in his lump sum price of manholes and ventilation shaft.

## **SECTION –11**

### **STEEL WORKS FOR DOOR, WINDOWS AND VENTILATORS**

#### **11.1 SCOPE OF WORK**

The work covered by this section of the Specification consists of furnishing all plant, labour, equipment appliances, and materials and in performing all operations in connection with the furnishing and installing of steel doors, windows etc; complete, in strict accordance with this section of the Specifications and the applicable drawings, and subject to the terms and conditions of the Contract.

#### **11.2 MANUFACTURER**

The drawing and details show profiles and design of door windows and ventilators etc; and pressed steel frames and these specifications describe minimum requirements. Stock fabricated items complying with these profiles, designs and requirements may be used subject to approval of the Engineer and provided the quality is at least equal to that specified. The work required under this section shall be made by approved manufacturer regularly engaged in the production the kind of the work shown and specified.

#### **11.3 SHOP DRAWINGS**

The Contractor shall prepare shop drawings of all work under this section. These drawings, illustrating in detail profile gauges of metal, details of construction to other work fastenings anchors, reinforcing for hardware, and all other pertinent information shall be submitted to the Engineer for approval.

#### **11.4 METAL DOORS AND WINDOWS ETC.**

- 11.4.1 All shapes shall be formed, rolled and formed or cold drawn with contours and rises as true and sharp as can produced in the thickness of metal required. With approval of the Engineer doors, windows etc. shall be a local product conforming to the requirements of the specification.
- 11.4.2 Construction Joints of steel work shall be welded full depth and width, or equivalent splice plates shall be welded on unexposed faces of frames. Exposed surfaces welded joints shall be dressed to produce invisible connection. Spot welding shall be used where practicable in preference to the use of rivets, screws, or bolts.
- 11.4.3 The finished work shall be strong and rigid, neat appearance and free from defects. Plain surfaces shall be smooth and free from warp or buckle. Moulded member shall be cleaned out straight and true. Mitres shall be well formed and in true alignment. Fastenings shall conceal where practicable.
- 11.4.4 Cut-outs shall be accurately located and made to fit the hardware. Cut-outs shall have dust covers of galvanized sheet welded in place to prevent mortar and plaster from contact with the reinforcing plates and lock strikes.
- 11.4.5 Reinforcing for hardware shall be provided in doors and windows etc. The reinforcing shall be concealed, welded in place and tapped for hardware fastenings.
- 11.4.6 Fittings for hardware shall be done at the factory to template or to the hardware. Metal drips shall be provided on the lower rails of hinged doors in exterior openings. They shall be formed 16 gauge steel and shall be tap screwed in place at not over 150 mm (6") intervals. Bolt sockets shall be provided in concrete under sliding doors and located where directed. These sockets shall consist of lengths of pipe set into the concrete while it is still green.
- 11.4.7 Doors shall have not more than 3 mm (1/8") clearance at jambs and heads and not more than 4.5 mm (3/16".) clearance from floor or from threshold at the bottom and shall

have the proper level on lock stiles or rails to operate without bending. They shall be made strong and reinforced at corners sufficiently to prevent sagging or twisting.

- 11.4.8 The doors should be made from mild steel sheeting of specified thickness and braced in mild steel standard sections obtained from approved supplier. Doors, windows etc shall also include angle iron frame as approved by the Engineer. These shall be complete with heavy-duty hinges, handles, bolts for fastening to lintel, and floor and locks. Each swinging leaf shall be provided with three (3) heavy steel half surface template butt hinges. Double doors shall be provided with astragals. Sliding leaves shall be equipped with steel tracks, track brackets, trolleys, guides, and stops bearing. Each sliding door shall be equipped with a cam bolt and nut and staple for locking with a pad lock. Tracks shall be of hot rolled steel and of sufficient weight.
- 11.4.9 Glazing to windows and Ventilators shall be provided by the Contractor of best Pakistani made sheet glass of specified thickness having no defects, blemishes or cracks. Proper arrangement for fixing the glass with best quality putty, wooden beading and clamps etc as approved by the Engineer shall be provided. The rate quoted for windows and ventilators should also include the cost of providing glazing.
- 11.4.10 The Pressed Steel Door Frames shall be fabricated from 16 gauge steel or as specified and directed by the Engineer. Edges of flanges shall be turned to form plaster keys where plaster occurs and to form retainers for adjustable anchors.
- 11.4.11 Adjustable masonry anchors for frames in masonry shall be of steel T-shaped and of the same thickness as metal of the frames. The head shall have equivalent strength and shall positively engage the retainers on both flanges of each jamb member when in place. The stem shall be corrugated for mortar bond and extend 10 inches in to the masonry. The stem generally shall be 3 inches into the masonry. The stem generally shall be 3 inches wide in masonry having a nominal thickness of 3 inches or less. Anchors shall be placed near the top and bottom of each jamb and at intermediate points not over 3 feet apart and shall lie flatly in the masonry joints. A clip shall be provided at the bottom of each Jamb.
- 11.4.12 Reinforcement for door butts, door closers, close bracket, locks and latch strikes shall be 4.5 mm (3/16) plate; butt reinforcement 150 mm 6" longer than butt; 16 gauge steel housing back of strike reinforcement.
- 11.4.13 Base angle for fastening to floor shall be welded to each jamb section.
- 11.4.14 Provide removable angle spreaders securely fastened to each Jamb.
- 11.4.15 Install frames Plumb, rigid and in true alignment and brace to retain position and clearance during construction of partitions.
- 11.4.16 Shop Painting: Metal doors window, ventilators and frame shall be cleaned by a hot dip phosphate or a cold phosphate chromate treatment standard with the manufacturer. Immediately after drying, these shall be applied shop coat of rust-inhabitive paint which will produce hard tough film of good appearance, flexibility and true resistance. Shop coat shall be applied on both exposed and inside surfaces and surfaces inaccessible after erection. After erection final
- 11.4.17 Painting of three coats of approve enamel paint shall be done. No separate payment for painting doors, windows and ventilators etc will be allowed.

## **11.5 ERECTION**

Doors, windows, ventilators, frames, and related work shall be hung and adjusted in their proper locations so that they operate properly and are in a condition satisfactory to the Engineer.

## **11.6 G.I. PIPE RAILING**

Pipe railing shall be of 2" (50 mm) diameter and shall include all pipes, bends, tees etc. with vertical posts and horizontal bracings of G.I. pipes of same diameter as per design approved by the

Engineer and shall include cost of threading, cutting and embedding / fixing at any level in CC 1:2:4 complete including 3 coats of approved enamel paint over a coat of primer as per drawing and instructions of the Engineer.

#### **11.7 STEEL GRILLS AND RAILING**

These shall be of design and type shown in the drawings or of pattern approved by the Engineer. M.S. Flats of specified size shall be welded to steel frame of similar section which shall be fixed / screwed to windows / ventilator frames. Grills shall be installed on the inner or outer side of the frame as desired and directed. Grills/railings shall be painted with two coats of primer and three coats of approved quality of enamel paint.

#### **11.8 STEEL LADDER**

Steel ladder shall consist of specified size of M.S. flats in strings and 1" (25,mm) diameter M.S. steel bars in rungs. The M.S. rungs shall be riveted and welded in 25 mm diameter holes in flats. The ends of each climb of the ladder shall be embedded in the concrete.

All components of ladder shall first be painted with two coats of approved red oxide primer and then with three coats of black enamel paint. The steel ladder shall be fabricated installed as per drawing or as directed by Engineer.

Payment shall be made on the basis of approved tender rates for each item of accepted work as per contract.

#### **11.9 FLUSH DOORS**

Flush doors shall be of high quality with a solid core covered on both sides with commercial ply of overall thickness of 40 mm. The doors shall be lipped and edges fitted and hung to frames. The flush door shall be obtainable from reputable manufacturer as approved by the Engineer. Hollow metal door frames shall be provided of approved sections and approved manufacture, fabricated with G.I. sheet and anchored to masonry by means of 'T' shaped M.S. hold fasts, 3 per jamb with bolts and nuts etc. Doors shall be made to tolerance of plus or minus 1.5 mm in height and width, and shall be flat with parallel faces and edges and accurately rectangular. The doors shall be provided with all the required hardware like locks, hinges and bolts etc. as approved by the Engineer and from an approved manufacturer. The door and the frame shall be complete in all respect including the cost of 3 coats of enamel paint of approved make and shade over a coat of primer.

#### **11.10 MEASUREMENT AND PAYMENT**

Measurement for the accepted quantity of doors, windows, ventilators where specified provided as per specification and directions of the Engineer shall be made as per standard method of measurements and payment shall be made as per the approved tender rates.

## SECTION – 12

### SUPPLY & INSTALLATION OF PUMPING MACHINERY & EQUIPMENT

#### 12.1 SCOPE

The work covered by these specifications consists of furnishing all plants, labor, equipments, appliances and material and performing all operations in connection with supplying, installation, testing and commissioning of pumps and motors with all accessories of electrical system & valves and pipe work inside the pump house including jointing material for pipes, fittings and valves in strict accordance with the specifications and terms and Conditions of the Contract.

#### 12.2 GENERAL

The pumps shall be either KSB or approved equivalent equipment. All components and accessories of pumps shall be the product of reputed manufacturer engaged in the manufacture of such pumps and equipments for the last ten years, and the materials supplied shall be the standard product of the manufacturer. The catalogues and other details of the pumps including characteristics curves of the pumps offered shall be supplied with the offer. The contractor shall get the details of pumps and equipment approved by the Engineer before placing order for the pumping machinery and equipment.

#### 12.3 DESIGN

The material, design, fabrication and assembly of equipment shall be in strict accordance with "American Water Works Association Standard E 101-61" American Standard or equivalent and the requirements given in these specifications and specific requirements of WASA for electrical equipment and installation.

#### 12.4 CENTRIFUGAL PUMPS SET

The centrifugal pump set shall consist of following basic components:

##### a) Centrifugal Pumps Electric Driven

The centrifugal pump shall be single stage, cast iron body, bronze impeller of radial type with double curvature vanes, stainless steel shaft sleeve for the pump shaft, properly lubricated bearings, readily accessible stuffing box with flanged discharge and suction connections, integral base plate of M.S channels for pump and motor, with drain outlet connected to nearest drain point, flexible coupling between motor and pump shaft covered with approved guard, pump casing to be complete with drain plug and vent plug.

The pump shall be capable of pumping the required quantity of water to the required total head as specified in BOQ while running at the specified rpm with a minimum efficiency of 70 percent when operating continuously without heating the motor, bearings etc. The casing shall be tested twice the maximum working pressure.

##### b) Electric Motor

The centrifugal pumps shall be directly coupled with electric motor 3 phase, 400 volts 50 cycles of required rpm and horse power on common base plate, suitable for working with the centrifugal pump. The motor shall have class E insulation and shall be continuously rated as laid in BS 5000.

##### c) Motor Control

The motor controls shall consist of a combination motor starter and push-button control with all necessary components, for a complete installation. Each motor- Control shall be suitable for controlling and operating 380-400 volts, 3 phase, 3 wires, 50 cycle electric supply. Motor controls shall be furnished in complete accordance with the applicable standards and shall have a minimum insulation level of 600 volts. The combination motor starter shall consist of circuit

breaker and magnetic starter and shall be designed to provide protection for the motors for short circuit. Protection in all three phases, under voltage protection in all three phases and overload protection in all three phases and shall provide for automatic stopping of motor if the sump is dry without sewage. The motor control equipment shall be carefully and securely mounted. The "Start" and "Stop" push buttons and the thermal overload relay reset device shall be mounted to be operable without the necessity of, opening the casing. Motor control shall be furnished complete as a unit with all component parts and accessories including ampere meter volt meter, phase indicating lights etc completely wired. The conductor shall be 600 volts heat-resistant rubber insulated type RH wire, or, moisture and heat-resistant, rubber, with 50 degree centigrade as the operating temperature.

#### **12.5 QUALITY CONTROL TESTS**

The manufacturer shall perform all the quality control tests during manufacturing and all test results shall be submitted in triplicate, along with characteristics curves of the pumps offered to the Engineer before procurement of pump sets.

#### **12.6 DEVIATION FROM SPECIFICATIONS**

Water pumps differing in minor respects from that specified may be proposed, provided such differences are clearly stated in the proposal.

#### **12.7 GUARANTEE**

Equipment furnished under this section shall be guaranteed for a period of one year from date of acceptance thereof against defective materials, design, and workmanship. Upon receipt of notice from the Engineer -inCharge of failure of any part of the guaranteed equipment during the guarantee period, new replacement part or parts shall be furnished, installed and commissioned promptly by the Contractor and no additional cost shall be payable to Contractor.

#### **12.8 MAINTENANCE MANUAL**

The Contractor shall furnish 3 copies of the illustrated maintenance and installation manual for all electrical and mechanical equipment. The Contractor shall furnish complete priced list of spare parts required for the operation of electrical and mechanical equipment for a period of two years.

#### **12.9 PACKING**

The Contractor shall ensure proper packing of the components of pump assembly for safe shipment.

#### **12.10 INSTALLATION OF HORIZONTAL CENTRIFUGAL PUMP**

The pumps shall be carefully installed as per drawings and manufacturers instructions. These pumps shall be mounted on separate concrete foundation to be built by the contractor with foundation bolts grouted at appropriate positions. Separate suction pipes shall be provided for each pump with combined delivery pipe work with all valves and fittings as per drawings and instructions of the engineer.

#### **12.11 INSTALLATION OF MOTOR CONTROLS & WIRING**

- a) 'The installation of the motor controls including voltmeter, ampere meter, indication lights for phases and other electrical equipment. and materials shall conform to the applicable requirements of local electricity authority. The Contractor shall submit the required documents including required test certificates considered necessary before power connection to the pumping station. The motor controls and other electrical equipment and materials shall be installed at appropriate location subject to the approval of Engineer.
- b) All wiring between the motor, motor controls and other electrical equipment shall be of adequate size for the requirements and of adequate insulation and shall run in P.V.C. conduits. Conduit sizes shall be adequate for the size and number of conductors for each circuit. The conduit pipe shall run exposed and supported at suitable intervals.

The ends of conduits shall be protected as required to prevent the entrance of concrete, sand or other foreign material during installation and afterwards. All conduits shall be installed with proper fittings and supports and all bends shall be gradual and smooth to permit pulling of conductors without damage. The radii of all conduit bends shall be not less than that of standard or long radii bends for the applicable size, shall be free from kinks, indentation, or flattened surfaces. Bushing, chase nipples or approved connectors shall be installed on the ends of the conduit at boxes and cabinets to protect conductors from abrasion.

#### **12.12 OPERATION AND ACCEPTANCE TESTS**

The operation and acceptance tests shall include a Physical inspection of the completed machinery installation, testing of the insulation resistance of the electrical wiring, resistance measurement of the grounding system and an operating test of the pump, (riots) and motor controls, as a complete installation.

The insulation resistance test of the electrical wiring and resistance measurement test of the grounding system shall be carried out as per requirements of electrical department.

Upon completion of the electrical insulation resistance tests and grounding system test, the Contractor shall conduct an operating test of complete installation to (demonstrate that the equipment function properly. The test shall consist of operating the equipment as a unit continuously for a period of seven days for each pumping unit. During this period the Contractor shall provide full operating staff, lubricants and other materials. If there is any indication during this period of defective materials or workmanship, the Contractor shall make any or all necessary replacements or repairs, following which the acceptance tests shall be re-run. The Contractor shall furnish all pipes fittings and gauges, equipments and accessories all of which shall be subject to the approval of the Engineer. The Contractor shall give the Engineer 24 hours notice before conducting the test, and the Engineer or his Representative will be present during all tests. The Contractor shall take draw down and discharge measurements, power input readings, and other pertinent data on forms furnished by the Contractor and approved by the Engineer. The originals of all such forms shall be delivered to the Engineer.

#### **12.13 MAINTENANCE PERIOD**

The contractor shall be responsible for operation and maintenance of pumping machinery and equipment for a period of 3 months. The Engineer shall arrange all operating staff, power, lubricants and other requirements. The contractor shall depute his full time supervisor for operation timings during this period. During this period the contractor at his own cost shall replace all defective parts and components. The Contractor shall be responsible for a further period of maintenance. This maintenance period shall be counted from the date of issue of certificate of commissioning by the Engineer or date of last replacement of spare of component part of equipment or date of taking over the pumping station from the Contractor.

#### **12.14 MEASUREMENTS AND PAYMENT**

No separate payment shall be made for supply of pumping machinery and equipment. The work shall be measured and paid on the basis of approved tendered rate in the Contract. The rate shall be inclusive of all plant, tools, equipments labour and all components, for installation testing, commissioning and satisfactory performance after commissioning and during the maintenance period and including all overheads and profits.

## SECTION - 13

### CONSTRUCTION, DEVELOPMENT AND TESTING OF TUBEWELL

#### 13.1 Scope

The work covered in these specifications consists in furnishing all plant, labor, equipment, appliances, and materials required for performing all operations in connection with the construction of Tube-well in accordance with these specifications and drawings.

#### 13.2 Drilling of Tubewells

Drilling of tubewells shall include, moving in, setting up, preparing the site, drilling the bore hole, collecting data and removing temporary casing, dismantling, moving out and cleaning up. Measurement for drilling of tube-wells will be made of the actual depth of borehole drilled, measured from the original ground surface. No measurement will be made of over drilling required because of sloughing, caving ground or for the Contractor's fault in casing; for tubewell abandoned due to jammed tools, caving ground, or negligence on the part of the Contractor; or for tubewells not constructed in accordance with all of the requirements of these specifications.

- 13.2.1 The Contractor shall drill bore hole at the location shown on the drawings. The diameter of the borehole will be 101. The Contractor shall prepare the site for the construction of the tubewells and shall arrange for the disposal of water, cuttings, and bore soils away from the tubewell.
- 13.2.2 The bore hole shall be drilled by the Reverse Circulation Rotary Method. Bore hole shall be drilled to a depth of 400 ft. or as specified by the Engineer Incharge. It is anticipated that the depth of tubewells may vary; however, no minimum depth for tubewell or average depth is guaranteed. The bore holes shall be drilled sufficiently straight and plumb so that the pump and tubewell casing may be installed concentric with the hole and within the tolerance specified for plumpness of the casing that is from ground level to a depth of 90 feet, the bore hole shall be absolutely, vertical, straight and in plumb, and for the remaining depths, deviation should not exceed ½% (half per cent).
- 13.2.3 The Contractor shall be responsible for protecting the tubewells from contamination by foreign material until the completed tubewell and appurtenant facilities are the completed tubewell and appurtenant facilities are accepted by the Engineer Incharge. The Contractor shall bear any expense needed to make good damage to tubewell, tools, or equipment that may be caused by caving, washing, or other disturbance within the tube-well.
- 13.2.4 If unstable material is encountered in drilling, the Contractor shall stabilize the material. The use of drilling fluid additives or other suitable materials may be employed in stabilizing the borehole with the approval of the Engineer Incharge. If necessary, temporary casing shall be furnished and installed by the contractor to hold the walls of the hole during drilling operations and until the gravel shrouding has been placed. All temporary casing shall be removed by the contractor in stages as the gravel shrouding is placed. The temporary casing may be new or used and will remain the property of the Contractor.
- 13.2.5 If, in opinion of the Engineer Incharge, it is necessary to discontinue work on any bore because it is out of line more than the amount specified or on account of jammed tools, caving ground, or because of negligence on the part of the contractor; the contractor shall drill another bore hole at an alternative location. The Contractor will not be entitled to payment for any work done or

materials furnished for bore holes abandoned as a result of his negligence.

### **13.3 Data and Records:**

13.3.1 The Contractor shall keep an accurate drilling log of bore hole, including a description of all materials encountered and their location in the borehole. In the case of defective or incomplete records, the contractor shall complete the records of his own expense. All records and data shall be kept by the Contractor on approved forms. The Contractor shall deliver to the Engineer Incharge the original of all records.

13.3.2 Representative whole samples or cuttings of the material penetrated shall be taken at each lithology encountered and from each 10 feet depth of the borehole. Special care shall be exercised to determine the thickness and location of each change in material encountered and to obtain satisfactory samples. Immediately upon taking each sample, the sample shall be placed in Polythene bag, partitioned wooden box or other approved container, properly marked for identification and plainly labeled with the depth of the top and bottom of the section of the bore hole represented. The Containers shall be furnished by the Contractor. The method of obtaining, processing, and storing the samples shall be subject to approval by the Engineer Incharge. The Contractor shall deliver all samples to the field headquarters of the Engineer Incharge on completion of boring work.

### **13.4 Tube-well Piping**

Tubewell piping shall consists of all works required in connection with the installation of Pump housing, blind pipes, strainers, Bail plug, centralizer etc. Concentric reducers will be considered as casing of the larger size to which the reducers are directly connected.

#### **13.4.1 Reducer**

The bottom end of the pump housing pipe shall be connected to mild steel tapered reducer of diameter 121x81, by means of coupling. The other end of the reducer shall be connected to the top end of the blind pipe.

#### **13.4.2 Pump Housing and Blind Pipe**

Mild steel welded pipe 3/164 thick shall be provided as per drawings or as directed by the Engineer Incharge for pump housing and blind pipes.

#### **13.4.3 Strainer**

Brass strainer of 81 diameter, approximately 120 feet long:

##### **13.4.3.1 Brass Strainer:**

Brass Strainer shall be of the type suitable for installation in the tubewells. It shall be the product of a manufacturer currently engaged in the commercial production of brass strainers for tubewells. Workmanship shall be of the highest grade and in accordance with the best modern practice. Material not definitely specified shall be of the quality regularly sold by the manufacturer in the Market.

##### **13.4.3.2 Quality of Strainer:**

The strainer shall be of the non- continuous slot type. The strainer shall be designed to produce a minimum loss of head or draw down between the water bearing strata and the well with 1/84 wall thickness.

**13.4.3.3 Openings:**

Strainer openings shall be machine cut openings 3/32 inch in width. The area of openings shall be minimum 15 percent in case of 8 inch well screen. The number and area of opening shall be such that the expected yield of the well may be developed with minimum of openings or slots and shall be so designed as to prevent clogging and shall be free from jagged edges, irregularities, etc., that will accelerate clogging.

**13.4.3.4 Strength:**

The strainer shall have adequate strength to resist the external forces that will be applied after it is installed and to minimize the likelihood of damage during the installation. The strainer shall not be liable of change of alignment at any of its joints after installation.

**13.4.3.5 Fittings:**

The strainer and blind pipe shall be provided with suitable couplings. All fittings including couplings, where required for joining sections of the strainer, shall be constructed of the same material as the strainer.

**13.4.4 Bail Plug**

The bottom of the tubewell shall be provided with the bail plug of suitable size of M.S. welded pipe approved by the Engineer Incharge.

**13.4.5 Centralizer**

Centralizer shall be provided at 2F ft. interval along the depth of tubewell. NO measurement shall be made of Centralizers, bail plugs or other accessories required for the complete installation.

**13.4.6 Lengths**

The lengths, diameter and material of all kinds of pipes strainers shall be got approved from the Engineer Incharge before installation by the Contractor.

**13.4.7 Fabrication:**

13.4.7.1 The depth of pump housing pipe of mild steel, shall be established by the Engineer Incharge for each tubewell depending on local sanitary conditions of shallow ground water and depth of pump setting.

13.4.7.2 Adjoining sections of pump housing pipe shall be assembled by field welding, with butt welding straps.

All field welding shall be performed by the electric arc method.

**13.5 INSTALLATION**

13.5.1 The Contractor shall install the entire pump housing assembly straight, plumb, and concentric in the drilled hole, to permit the installation of the pump in such a manner that it will operate satisfactorily and without damage. The methods employed by the Contractor in the installation of the casing and in obtaining or correcting the verticality and straightness of the pump housing casing, shall be subject to approval of the Engineer Incharge.

13.5.2 Centralizer shall be attached to the pump house casing so that it will be centered in the drill hole

throughout its entire length and held in such position while gravel shrouding is being placed. Centralizer will be placed at 25' intervals throughout the length of the tubewell.

- 13.5.3 Measurements for determining the deviation of the pump housing casing from the vertical shall be made by the use of a circular plumb having a minimum outside diameter of 1/5 inch less than the inside diameter of the pump housing casing. When the plumb is lowered to the bottom of the pump housing casing, the line from which the plumb is suspended shall not deviate from the centre of the pump housing casing at the top, by more than 1/5 inch at the bottom of the pump housing casing. All deviations shall refer to a vertical line passing through the centre of the pump housing casing at the top of the pump housing casing.

- 13.5.3.1 Straightness shall be determined by lowering a section of pipe 4E feet long or a dummy of the same length to the bottom of the pump housing casing. The minimum outside diameter of the pipe or dummy shall be 1/5 inch less than inside diameter of the pump housing casing.

If a dummy issued, it shall consist of a rigid spindle with three cylindrical rings, each ring having a height of at least 15 inches. The rings shall be true cylinders and shall be located at each end in the centre of the dummy.

The central shaft of the dummy shall be rigid so that it will maintain the alignment of the exist of Cylindrical rings. The pump housing casing shall be sufficiently straight so the pipe or dummy can be passed freely through out the entire length of the pump housing casing.

- 13.5.3.2 Any tube well failing to meet the specified requirements for straightness, verticality and concentricity shall be abandoned, and the contractor shall construct a new well at his own expense at an alternative site designed by the Engineer Incharge.

## **13.6 GROUTING**

The annular space outside of the pump housing pipe shall be sealed with cement grout. Grout shall consist of one part of cement to one part of sand by volume and not more than F 1/5 gallons of water per cubic foot. The annular space shall be flushed with water prior to grouting to ensure that the space is open and to remove foreign material. The grout shall be placed through a minimum 3/4 inch diameter grout pipe extending to the bottom of the annular space initially and shall remain submerged into the grout during the entire time the grout is being placed to ensure complete filling of the annular space. The grout shall be pumped into the pipe or applied continuously by gravity. The pipe may be left in place or it shall be gradually removed. In the event of interruption in the grouting operations, the bottom of the pipe shall be raised above the grout level and shall not be re-submerged until all air and water have been displaced from the grout pipe. The grout shall be allowed to set a minimum of 5 days after a placement prior to resuming work on the well.

## **13.7 GRAVEL SHROUDING**

Gravel shrouding shall consist of all work required in connection with supplying and installing gravel shrouding in the annular space between the strainer and the walls of the bore hole, from the bottom of the strainer to top of the strainer and from top of the strainer to 3E ft. above, after developing and testing, stock-piling, grading, washing, storing, and installing gravel shrouding in the tubewell. Measurement for gravel shrouding will be made of the depth of the gravel shrouding actually furnished and placed in the tubewell.

**13.7.1 Material**

All gravel used for shrouding shall be clean, hard, well rounded, washed, carbonate free, and water worn, without thin, flat particles and with the following gradations:

1.5 millimeters to 75 millimeters uniformly graded.

OR

British Standard Screen/Sieve	Per cent passing
3/8 inch	100
No. 4	60 - 80
No. 7	20 - 40
No. 14	0 - 5

**13.7.2 Installation**

The specified spaces shall be gravel surrounded by the Contractor from the bottom to 3E ft. above the top of the Strainer in such a manner that there will be no voids other than the inter granular space between the gravel particles. Water shall be circulated in the tube-well, as the gravel is being placed, by lowering the drill pipe inside the casing and operating the circulation pump. The gravel shall be placed to the top of the tube-well and shall be finally settled by bailing after all gravel had been placed temporary casing, if used, shall be carefully withdrawn in 5 to 10 feet stages during placement of the gravel shrouding and the gravel shall be introduced so that each stage of the hole above the bottom of the casing is completely filled before the casing is withdrawn to the next stage.

**13.8 DEVELOPMENT TESTING**

Development and testing shall consist of all work required in connection with the development of tubewell to produce the design capacity of relatively sand-free water with a minimum draw down, and the testing of tube-well to determine the effectiveness of the development operations as specified herein.

Development and testing shall include, but not limited to surging, back washing, and pumping and tubewell at higher than rated capacity; testing the tubewell for specified capacity, and sand content and degree of development; and disinfections and sealing tubewell.

**13.8.1 Development**

The tubewell will be developed either by compressed air or by piston types slugger. The development will be carried out in the presence of the Engineer Incharge or his representative. The Contractor shall maintain a complete record of the development operation and shall make regular periodic measurements of discharge rates, sand content and water level measurements. The procedures used shall include back washing and pumping at higher than rated capacity and may include surging or similar procedures determined by the Contractor. The development of the tubewell shall be performed for a minimum of six hours by step pumping, back washing and surging the tube-well with a vertical turbine pump. The Contractor shall notify the Engineer

Incharge following the completion of the six hours pumping period that the tubewell is ready for testing.

### **13.9 TESTING**

**13.9.1** The Contractor shall test tube-well under the direction of the Engineer Incharge as described herein upon completion of the development operations the tube-wells shall be permitted to recover for a minimum period of one hour. During this recovery period, the tube-well shall be sounded. If the comparison of the depth by sounding and length of the casing string indicates that there is more than six feet of materials in the tube-well, it shall be cleaned to within feet of the bottom of the bail plumb.

**13.9.2** Following the recovery period, the tube-well shall be pumped at 150 percent of rated capacity for a period of one hour. At the end of the first five minutes of pumping the sand content of the water shall be determined by using a 1000 S millimeter. In off cone or other device approved by the Engineer Incharge. The sand content of the water shall be less than 100 ppm. A second sand content determination shall be made 10 minutes after the start of pumping. The sand content at this time shall be less than 30 ppm. If the sand content tolerances are exceeded at this time, or at any subsequent time up to the time of final acceptance of the installation, while pumping at the rate of 150 per cent of design capacity or less, the development of the tube-well shall be considered incomplete and the Contractor shall resume development of the tube-well will produce water meeting the sand content tolerances. Sand content determinations, water level, and discharge measurements during the remainder of the one-hour sand test period shall be made as directed by the Engineer Incharge.

**13.9.3** When the sand test has been satisfactorily completed, the tube-well shall be further developed for ' hours at 150 per cent of the rated capacity of the tubewell by surging and back washing with the test pump at five to ten minute intervals. Following the development period, the tubewell shall again be pumped for a period of one hour at 150 percent of design capacity during which time the sand test shall be repeated. The specific capacity of the tubewell shall be determined from the water level measurements and flow rates obtained during the pumping periods. If the specific capacity obtained from the second pump test is found to be more than 10 per cent greater than that obtained in the first pump test, the development shall be considered to be incomplete and the contractor shall resume development, at his own expense, until the tube-well is development sufficiently to meet this requirement.

**13.9.4** Upon satisfactory completion of the above 1 hour pumping period the tube-well shall be permitted to recover for a period of one hour. Upon the completion of this recovery period, a four hour multiple step pump test shall be performed by pumping the tube-well for one hour at each of approximately four equal increments. The last increment shall be at 15E percent of rated capacity. Following this last increment of the step test, the tube-well shall be pumped at a rate of 15E percent of design capacity for a period of two hours.

### **13.10 SUMMARY**

The following is a short summary of the development and testing procedure:

#### **13.10.1 Development**

Development Time 6 hours (Minimum) Recovery 1 hour (Minimum)

#### **13.10.2 Testing**

Pumping period 1 hour

Development 4 hours

Pumping period 1 hour

Recovery 1 hour (Minimum)

Step Pumping 4 hours

Pumping period 2 hours

#### **13.11 EQUIPMENT**

The Contractor shall furnish all necessary equipment for testing the tube-well, including a water-lubricated or oil lubricated test pump capable of delivering at least 150 percent of the tube-well rate capacity at all stages of the tests, a valve for fine adjustment of the discharge, an electric measuring device to determine the draw down during each stage of the test and In off cones to measures and content. If oil-lubricated test pups are used, the contractor shall exercise all reasonably precautions to keep the leakage of lubricating oil into the tube-well at a minimum and shall promptly remove all oil, which collects on the water surface in the tube-well by the addition of detergent or other suitable chemicals and pumping the emulsified oil from the tube-well.

#### **13.12 MEASUREMENTS AND DATA**

The Contractor shall take draw down and discharge measurements and other pertinent data during each test at intervals as specified by the Engineer Incharge. All such data shall be recorded on forms approved by the Engineer Incharge, and the original of such forms shall be delivered to the Engineer Incharge at the completion of the development and testing operations.

#### **13.13 DISINFECTIONS**

After development and testing of the tube-well has been satisfactorily completed, and when approved by the Engineering charge, the Contractor shall disinfect the tube-well by dispersing Chlorine solution throughout the entire depth of the well to obtain minimum chlorine content of 50 parts per million. The procedure and equipment used to introduce and disperse the chlorine in the tube-well shall be at the option of the Contractor, and shall subject to approval by the Engineer Incharge.

#### **13.14 SEALING**

Upon completion of disinfections of the tube-well the Contractor shall seal the tube-well by tack welding providing 1/4 inch thick steel plate cap to the pump housing pipe around its circumference. Compliance with this requirement will not relieve the Contractor of his responsibility for safe-guarding any part of the tube-well completed until the Certificate of Acceptance is issued for the entire tube-well installation.

#### **13.15 PAYMENT**

Payment shall be made on the basis of completed job of tubewell drilled or material supplied and installed dully approved and measured by the Engineer Incharge as per Bill of Quantities.

## SECTION S - 14

### PUMPING MACHINERY FOR TUBEWELL

#### 14.1 SCOPE

The work covered by these specifications consists in furnishing all plants, labor, equipments, appliances and material and performing all operation in connection with supplying, installing and commission of pumps and motors, supply of starters, control panels, and all electrical wiring upto control panel and main switches in strict accordance with the specifications and terms and conditions of the contract. The supply of control panels and main switches shall also be included in the quotations.

#### 14.2 GENERAL

Pumps shall be of the vertical turbine type for installation at tubewells and shall be suitable for use with vertical, hollow shaft totally enclosed squirrel cage, induction type motor. All pumps shall consist of pump bowl assembly, including water pre-lubrication system or equivalent as required and all other parts and appurtenances to provide a complete operating pump in accordance with these specifications.

#### 14.3 DESIGN

The material, design, fabrication and assembly of equipment shall be in strict accordance with 1American water works Association standard E 101-61 entitled 1American Standard for Vertical Turbine pumps of equivalent, and the following requirements:

##### 14.3.1 Line Shaft Vertical Turbine Pumps

The basic pump shall consist of the following three elements:

1. The pump bowl assembly shall be either a single or multistage, centrifugal vertical pump with discharge coaxial with the shaft.

##### 2. Column-and-Shaft-Assembly

The column and shaft assembly shall consist of a column pipe which suspends the pump bowl assembly from the head assembly and serves as conductor for the fluid from the pump bowl assembly to the discharge head. Contained within the column pipe shall be the line shaft, which transmits the power from the driver to the pump shaft. The line shaft is supported throughout its length by means of bearings which shall be lubricated with water. 10.3.1.3 Head Assembly The head assembly shall consist of a base from which the column and shaft assembly and the bowl assembly are suspended. And a discharge head, which will direct the fluid into desired piping system.

**Suction Strainer:** shall be without foot valve and shall have 10 feet suction pipe.

**The Driver Coupling:** The driver coupling shall transmit the power to the top shaft. It shall contain means for impeller adjustment and provides a bearing to carry the thrust load.

**Discharge Head:** A cast iron flange shall be internally cast on the discharge head. The discharge flange shall have a companion flange suitable for connection to the discharge pipe.

#### **14.3.2 Types of Prime Mover**

Prime movers shall be a vertical hollow-shaft motor, totally enclosed, fan cooled, squirrel cage with non-reverse ratchet, 40E-38E volts, 5E C/S ; Phase A.C. Supply, suitable of the pump for required capacity.

#### **14.3.3 Pneumatic Depth Gauge**

Gauge with direct reading scale on proper stand with foot air pipe of sufficiently length shall be provided with each pump to determine water level in tubewell at any desired time.

#### **14.3.4 Capacity**

The capacity of the pump is the volume rate of flow expressed in gpm. The capacity of the pump supplied shall be 50 imperial gallons per minute at the column pipe setting of 250 ft. of water at the maximum over all efficiency, which shall not be less than 8E percent under the designed load.

#### **14.3.5 Pump Speed**

The pump speed shall not exceed 145E r.p.m. 10.3.6 Pump Total Head The total dynamic head for which the pumps will normally shall be 25E feet.

### **14.4 MANUFACTURE**

The pump and motor shall comply with the following specifications and shall be the products of reputed manufactures engaged in the development/manufacture of the pump and motor for the last ten years. Final selection of the pump and motor shall be at the sole discretion of the Engineer Incharge.

#### **14.4.1 Pump Element**

The impellers shall be the enclosed skirt soil type, constructed old bronze according to ASTM B 14F-61 or equivalent. Impellers shall be accurately fitted, smoothly finished, and dynamically balanced at the normal pump speeds. The bowls shall be constructed of close-grained cast iron, and the pumps shall be multiple-grained cast iron, and the pumps shall be multiple-stage. Each suction bowl shall be fitted with a grease-packed bronze bearing and suction case plug. A suction case and collar shall be provided to protect the bearing. Pump bowl shall have a fluted rubber bearing above each impeller and shall be designed for ht future installation of bronze or cast iron wear rings. Each discharge bowl shall be equipped with a bronze bearing. The pump shaft shall be of stainless steel, conforming to ASTM Standard A 27&-6E or equivalent, and shall be of suitable size to transmit the loads and to maintain correct alignment without distortion or vibration. The shaft shall be turned, ground and polished and shall be threaded for connection to the line shaft.

#### **14.4.2 Column pipe and Line Shaft**

The column pipe shall be furnished in interchangeable sections having a nominal length of 1E feet and shall be not less than \$ inches in diameter. Wall thickness shall be a minimum 0.25 inch. The ends of each column pipe section shall be faced parallel and perpendicular to the-exist of the pipe. The threads shall be machined so the adjoining sections of column pipe will but together to ensure proper alignment on assembly. The line shaft shall be of ground carbon steel shafting, conforming to ASTM A-108-61 or equivalent. The line shaft shall be furnished in interchangeable sections having a normal length of 1E feet. The internal diameter shall not be

less than 1-3/8 inches. The ends of the shaft sections shall be faced parallel and perpendicular to the axis of the shaft. Adjoining sections of the line shaft, designed to tighten under pump operation. The line shaft shall be supported by fluted, oil resistant, rubber bearing shall be replaceable within the bronze bearing retainers and shall be spaced at intervals of not more than 1E feet along the line shaft.

#### **14.4.3 Surface Discharge Heads**

Surface discharge head shall be of the above ground type and shall have a suitable base for supporting the specified electric motor and the pump column. The discharge head shall be of cast iron conforming to ASTM Standard A 48-65 or equivalent. The section of the water passage through the elbow shall be at least equal to 8 inches diameter. Each surface discharge head shall be furnished with a flange.

#### **14.4.4 Pre-lubrication System**

The contractor shall furnish a manually operated, water pre-lubrication system complete with all valves, piping and storage tank for each water pump. The pre-lubrication system shall be adequately sized to provide sufficient water for lubrication of the bearings during start up and until the normal lubrication is established. The piping for pre-lubrication system shall be complete with necessary valves, lines and fittings to permit filling of the pre-lubrication tank from the pump discharge and to permit the water to be manually released prior to starting the pump. The pre-lubrication tank shall be an enclosed tank of sufficient size to adequately lubricate the line shaft bearing before pump start up and shall be equipped with an opening in the top through which it may be filled from the pump discharge or from an outside source.

#### **14.4.5 Motor**

The pump motor shall be vertical, hollow shaft, weather protected, squirrel cage, induction type motor totally enclosed, fan cooled and shall be rated for operation at 1450 rpm on 380-480 volts; phase, 50 cycles of suitable horsepower at 50 degrees centigrade ambient temperature. The motor shall conform to NEMA Standard MG1, entitled "Motors and generators" or equivalent for a class B design and shall have low starting current and normal starting torque. The locked rotor input shall not exceed 5.6 KVA per horsepower. The winding shall have Class B insulation and shall be suitable for operation under condition of high humidity and at an ambient temperature of 50 degrees centigrade. Each motor shall be equipped with three thermal devices embedded and symmetrically spaced in the stator winding. These devices shall operate on temperature rise to de-energize the control circuit the motor thus disconnecting it from the power source. The thermal devices shall be so located in the winding and so constructed that they will prevent motor damage due to over-heating resulting from overload, lack of ventilation, single phasing, stalling, a high ambient temperature or voltage imbalance.

#### **14.4.6 Pump Motors**

The pump motors shall be designed for mounting on the surface discharge head and for direct connection to the line shaft. A thrust bearing of adequate capacity to carry the weight of all rotating parts, plus the hydraulic thrust, shall be provided on each motor. The motors shall be equipped with ball bearings and provided with a complete oil or grease-lubricating system, including all necessary sight gauges and fill and drain connections for each bearing. Each motor shall be provided with a non-reverse ratchet to prevent reverse rotation of the pump.

#### **14.4.7 Motor Control**

The motor controls shall consist of a combination motor starter and push-button control with all necessary components, for a complete at the range of 380 to 400 volts, and shall be suitable for controlling and protecting one 380-400 volts, ; phase, ; wire, 50 cycle electric motor. Motor controls shall be furnished in complete accordance with the applicable standards and shall have minimum insulation level of 60E volts. The combination motor starter shall consist of circuit breaker and magnetic starter and shall be designed to provide protection for the motors for short circuit protection in all three phases, under voltage protection in all three phases and overload protection in all three phases. The motor control equipment shall be completely enclosed within a casing and shall be carefully and secretly mounted. The "Start" and "Stop" push buttons and the thermal overload relay reset device shall be mounted to be operatable without the necessity of opening the casing. Motor control shall be furnished complete as a unit with all component parts and accessories completely wired. The Conductor shall be 600 volts heat-resistant rubber insulated type RH wire, or a moisture and heat-resistant, rubber, with 50 degree centigrade as the operating temperature.

#### **14.5 QUALITY CONTROL TESTS**

The manufacturer shall perform all the quality control tests as specified hereafter and all test results and field performance curves shall be submitted, in triplicate, to the Engineer in-Charge.

##### **14.5.1 Standard Running Test**

The pump bowl assembly shall be operated from zero capacity to the maximum capacity shown on the performance curve submitted with the manufacturer's bid. Readings shall be taken at a minimum of F points, including one point within 5 percent of the design capacity specified, and down to minimum level of 10'. The pump shall be operated at a speed within F percent of the design speed.

##### **14.5.2 Capacity Measurement Test**

The capacity of the pump shall be measured by means of a standard venturi tube, nozzle, orifice plate or pilot tube traverse.

##### **14.5.3 Head Measurement Test**

For head measurement in excess of 3& feet, calibrated before or other gauges with equivalent accuracy and reliability shall be used. All gauges shall be calibrated before and after each series of tests.

##### **14.5.4 Test for Velocity Head**

The average velocity in the pump column, used to determine the velocity head, shall be calculated from dimensions obtained by actual measurement of the pipe and shaft, or enclosing tube diameter at the point of pressure arrangement. If the pressure tap is located.

##### **14.5.5 Horsepower Input Test**

The power input to the pump shall be determine with vertical dynamometer or a calibrated electric motor. The torque of the dynamometer shall be measured by means of a calibrated strain gauge or other device of equivalent accuracy.

**14.5.6 Measurement of Speed**

The rotating speed of the pump shall be obtained by a hand counter, electronic computer or a stroboscope counting slip.

**14.5.7 Hydrostatic Test**

A standard hydrostatic test on the pump bowl assembly shall be made at 1 1/5 times the shut off head developed by the pump bowl assembly or at twice the rated head, whichever is greater.

**14.5.8** The Contractor shall carry out relevant verticality test of the bore hole before installing the pump.

**14.6 DEVIATION FROM SPECIFICATIONS**

Water pumps differing in minor respects from that specified may be proposed, provided such differences are clearly stated in the proposal.

**14.7 GUARANTEE**

Equipment furnished under this section shall be guaranteed for a period of one year from date of acceptance thereof against defective materials, design, and workmanship. Upon receipt of notice from the Engineer Incharge of failure of any part of the guaranteed equipment during the guarantee period, new replacement part or parts shall be furnished promptly by the Contractor and no additional cost shall be payable to Contractor.

**14.8 MAINTENANCE MANUAL**

The Contractor shall furnish; copies of the illustrated maintenance and installation manual with each pump. The Contractor shall furnish complete list of spare parts required for the pump operation.

**14.9 SPARES AND TOOLS**

The Contractor shall furnish the following common spares such as bushing, bearings, other similar items and special tools with each pump for its efficient services for 5 years.

**14.10 PACKING**

The Contractor shall ensure proper packing of the components of pump assembly for safe shipment.

**14.11 INSTALLATION OF PUMPING MACHINERY AND EQUIPMENT**

**14.11.1** Adequate foundation shall be constructed for pumps and motors for the required performance.

**14.11.2** The Contractor shall chain, assemble, align and install the pumps, motors and all equipments and accessories including piping and fittings in good workman like manner and in accordance with the manufacturers recommendations.

**14.11.3** Material and equipment used in all electrical works shall be new and latest Standard product of a manufacturer regularly engaged in the production of such material for at least 10 years.

**14.11.4** All electrical works including motors, switches and starters etc. shall be ground as per requirements of Electricity Department.

**14.12** After completion of the installation of Pumping Machinery and all equipment, the whole installation shall be put to trial operation and commissioning. The Contractor shall be responsible for a trial maintenance for a period of one month before taking over the whole installation and works by the Engineer Incharge. During this period all the other charge shall be borne by the Contractor. During this period the Contractor shall remove and replace all defective parts of machinery, equipment and other works at his own cost. The performance of Machinery during this period shall be same as per accepted performance curves supplied by the Contractor along with the Tender Documents.

**14.13 PAYMENT**

The Contractor shall be paid for the supplying, Installing, commissioning, testing and one month maintenance of pumps, motors including all accessories as one item as per Specifications, complete in all respect, on the basis of approved tendered rates in the Bill of Quantities.