



**Palestinian National Authority**  
PALESTINIAN WATER AUTHORITY



**السلطة الوطنية الفلسطينية**  
**سلطة المياه الفلسطينية**

# **GENERAL TECHNICAL SPECIFICATIONS**

## **FOR**

### **SEWERAGE SYSTEMS**

**PWA**  
**1999**



**Palestinian National Authority**  
PALESTINIAN WATER AUTHORITY



**السلطة الوطنية الفلسطينية**  
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## **PREMABLE**

Substantial activity in the water sector within Palestine is currently taking place and a major uplift and standards is currently being implemented. A rather large number of international agencies and donors are involved in technical and financial assistance in the water sector.

Needless to say, coordination and use of common standards and rules will be essential in the planning process if one is to succeed in implementing an effective system for the future

The Palestinian Water Authority PWA has been authorized by law No. 2 for 1996 to develop the framework for technical standards and specifications and to supervise and control compliance at all levels in the water sector.

The PWA reserves the right for carrying additional testing for any part of the works included in the contract, during and/ or after the execution of the work. In the event that the results of such tests are not satisfactory and not in conformity with the specifications requirements, the contractor shall bear the costs and any other implications of such tests. On the other hand if the results of the additional tests prove to be satisfactory the “direct costs” of carrying such tests will be covered and paid through a “provisional sum item” to be allowed for the Bill of Quantities, with a total sum of \$ 5000 US Dollar.

### ***Scope of Work***

This manual is the official framework regarding the General Technical Specifications for Sewerage Systems Projects



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## SECTION 1 - GENERAL

### 1.1 Definitions

In the Contract (as hereinafter defined) the following words and expressions shall have the meanings hereby assigned to them, except where the context otherwise requires :

- A
- (i) “Employer” - The party named in the Contract as the “FIRST PARTY” who will enter into contract with the Contractor for the execution of the Works covered by the Contract, or any other party authorized by the Employer to exercise the powers and obligations of the First Party, provided that the Contractor will be informed accordingly in writing.
  - (ii) “Contractor” - The person, company or joint venture named as Second Party in the Contract whose Tender has been accepted by the Employer and with whom the Employer has entered into Contract, and includes the Contractor’s personal agents and his legal successors.
  - (iii) “Subcontractor” - Any person to whom a part of the Works has been subcontracted by the Contractor with the consent of the Engineer and the legal successors in title to such person.
  - (iv) “Engineer” - The Consulting office, or Engineering office or Engineer or any other technical body appointed from time to time by the Employer to exercise in whole or in part the powers of the Engineer in accordance with the Conditions of the Contract. provided that the Contractor shall be accordingly notified in writing.
  - (v) “Engineer’s Representative” - Any resident engineer appointed by and be responsible to the Engineer and shall carry out such duties of watching and supervising the execution and workmanship of the Works and to test and examine any materials to be used or workshop employed in connection with the Works.
- B
- (i) “Contract” - The documents constituting the Conditions the Specification, the Drawings, the Bill of Quantities, the Tender, the Letter of Acceptance, the Contract Agreement, and such further documents as may be expressly incorporated in the Letter of Acceptance or Contract Agreement (if completed).
  - (ii) “Specifications” - The Technical Specifications of the Works included in the Contract and any modification thereof or addition thereto made or submitted by the Contractor and approved by the Engineer.
  - (iii) “Drawings” - All drawings, calculations and technical information of a like nature provided by the Engineer to the Contractor under the Contract at the time of entering into the Contract or during execution, and all drawings, calculations, samples, patterns, models, operation and maintenance manuals and other technical information of a like nature submitted by the Contractor and approved by the Engineer.
  - (iv) “Bills of Quantities” - The priced and completed bill of quantities submitted by the tenderer and forming part of the Tender.
  - (v) “Tender” - The Contractor’s priced offer to the Employer for the execution and completion of the Works and the remedying of any defects therein in accordance with the provisions of Contract, as accepted by the Letter of Acceptance.
  - (vi) “Letter of Acceptance” - The formal acceptance by the Employer of the Tender.
- C
- (i) “Commencement Date” - The date upon which the Contractor receives the notice to commence issued by the Engineer.
  - (ii) “Time for Completion” - The time for completing the execution of and passing the Tests on Completion of the Works or any section or part thereof as stated in the Contract calculated from the Commencement Date.

- D (i) “Tests on Completion” - The tests specified in the Contract which are to be made by the Contractor before the Works or any Section or part thereof are taken over by the Employer.
- E (i) “Works” - The Permanent Works and the Temporary Works to be executed in accordance with the Contract, or either of them as appropriate.
- (ii) “Permanent Works” - The permanent works to be executed (including Plant) in accordance with the Contract.
- (iii) “Temporary Works” - All temporary works of every kind (other than Contractor’s Equipment) required in or about the execution and completion of the Works and the remedying of any defects therein.

## **1.2 Specifications**

- A. These General Technical Specifications should be read in conjunction with the Product Standards which form a part of these Specifications.
- B. The General Technical Specifications cover the materials and works of civil engineering construction for sewer network, house connections, and ancillary works.
- C. Materials and works not covered by these specifications will be specified either in the Special Conditions of Contract and Specifications or in the Bill of Quantities.

## **1.3 Works Included**

- A. The Scope of the proposed Works shall be as delineated on the Drawings and set-out in the Particular Conditions and Specifications together with any Drawings which may be issued by the Engineer during the currency of the Contract.
- B. The Contractor shall, unless otherwise specified herein, supply all materials, equipment, temporary works, plant and labour necessary to install, complete and maintain the works required under the contract.
- C. The Works shall include but not be limited to, preparing the sewer line route including all setting out, etc., excavation for pipes and manholes to the required dimensions for the sewer trunk line, sewer network systems and house connections including extra excavation at joints and all working space for planking and strutting, etc., all works and temporary works necessary for maintaining the flow of traffic, provision of alternate detours, barricades, guards and warning lights, supply, lay and test the pipes, and fittings, backfill and consolidate trenches, pump and dewater, make temporary connections, reinstatement of surfaces, remove surplus material, clean up site of work and maintain the whole works such that it may be handed over to the Employer in good condition and working order and in full compliance with the requirements of these documents.
- D. The Contractor shall also furnish all equipment, tools, labour, materials, fittings, and specials required to make connections to the future sewers and sewerage systems, house connections and to protect or rearrange the existing sewerage system, conduits, ducts, services or other structures, or to protect, transpose and rearrange subterranean and visible cables for electricity, telephone, etc., to demolish existing pipes and other structures when called upon to do so by the Engineer so that the whole works are delivered to the Employer in perfect condition and working order.
- E. The Contractor shall supply all labour, supervision and technical services required for the work. All manholes, covers, pipes and fittings and other materials and items required shall also be supplied by the Contractor, and all materials and workmanship shall be in accordance with the requirements of this specification. In the event of any failure in respect of any tests carried out on any of the materials supplied by



the contractor, the same shall be replaced or repaired to the entire satisfaction of the Engineer at the Contractor's expense.

- F. The Contractor shall at his own expense maintain and repair any damage caused to highways, streets and underground structures by his vehicles, irrespective of any protective measure taken.

#### **1.4 Contract Drawings**

- A. The Contract Drawings shall be as delineated on the Drawings and set-out in the Particular Conditions and Specifications together with any other drawings which may be issued by the Engineer during the currency of the Contract.
- B. All lines, elevations and measurements shown on the Drawings are approximate and are intended to be used for tendering only. It shall be the Contractor's responsibility to verify and determine the exact lines, grades and elevations to the approval of the Engineer before commencing any section of the works.

#### **1.5 Standards and Units of Measurements**

- A. The works have been designed to incorporate and utilize economically high quality product standards and workmanship to various specifications which are detailed herein.
- B. A list of Product Standards attached to this document **shall be followed**. Preference shall be given to PS Standards (Palestinian Standards) and ISO Standards (International Standards Organization) as described in the attached list of Products Standards.
- C. Second priority shall be given to JSS (Jordan Standard Specifications) and IS (Israeli Standards). These shall be followed where described in this Technical Specifications and in the attached list of Product Standards.
- D. Other standards such as EN (European Committee for Standardization /CEN), BS (British Standards Institution / BSI), AFNOR (Association Francaise de normalisation), DIN (Deutsches Standards fur Normung), ASTM (American Testing and Material Standards), ANSI (American National Standards Institute), ACI (American Concrete Institute), AWWA (American Water Works Association) can **only** be used either if they are compatible and better than the relevant ISO Standards or when an ISO Standard is not covering the product. Documentation for this is to be attached to tender.
- E. All standards and references shall in every case be deemed to include the latest edition or issue of such standards.
- F. All units of weight and measurements shall be based on the Metric System of Weights and Measurements.

#### **1.6 Inconsistency in Contract Documents**

- A. The Contractor shall execute the Works according to the provisions of the Contract Documents. In the event of any unforeseen or unintended conflict between the Particular Conditions and Specifications and this Specifications, the former shall prevail.
- B. If the Contractor should discover that any work has been omitted and / or not indicated entirely or partially from all the documents, but that such work is essential to the safety or proper functioning of the Works, he shall report the facts immediately to the Engineer. If the work is something which in the opinion of the Engineer could not have been foreseen by an experienced Contractor, the Engineer shall issue to the Contractor a variation order stipulating the details of the work to be done. Save as aforesaid in the above

paragraph, no additional payment shall be made in respect of work carried out in connection with discrepancies between the various Contract Documents.

### **1.7 Temporary Contractor's and Engineer's Offices**

- A. The Contractor shall provide offices for the use of his Agent and foremen on the site in an approved position, all communications delivered at the contractor's temporary Site Office shall be deemed as having been delivered to the Contractor's Formal Registered Address.
- B. The Contractor shall also provide and maintain separate and proper offices for the Engineer and his representative on the site in an approved position.
- C. The Engineer's office shall not be less than 32 m<sup>2</sup> floor area, shall have a minimum headroom of 2.4 m and be divided into 2 rooms and shall have adequate car parking space.
- D. The office shall have concrete floors and shall be water-tight, weather proof, properly ventilated, sanitary equipped, adequately lighted, painted and fitted with secure lockable doors and windows and shall be furnished with 2 tables (1.40 x 0.80 meters) 8 chairs, 2 cupboards.
- E. The office shall be cleaned by the Contractor daily and the Contractor shall provide drinking water, heating and lighting if required, all at his own expense.

### **1.8 Temporary Water and Electricity Supplies**

- A. The Contractor shall provide all necessary water to the construction site both for carrying out the Contract and as potable water for his workmen at his own expense. This will be together with all temporary plumbing and storage, pay all charges, and alter, adapt and maintain temporary work as necessary and remove and make good at completion.
- B. The water shall be of a chemical and purity standard such that it will not be pollute, injure or cause any deterioration of the Works, and it shall generally comply with the requirements specified.
- C. The Contractor shall provide all necessary lighting and power for the execution and protection of the Works and for the Engineer's office facilities, with all meters, temporary wiring and fittings, etc., pay all charges, and alter, adapt and maintain the temporary work as necessary and remove and make good at completion.

### **1.9 Contractor's Representatives**

- A. Full information shall be given in the tender about age, theoretical education and practical training of the supervisors to whom is intended to entrust the performance on site of the works. Change of supervisors is not allowed without the written approval of the Engineer.
- B. The Contractor will be required to send one or more qualified engineer to all meetings with the Employer, the engineer or other parties at which his attendance is deemed necessary by the engineer. Such engineer(s) must have the authority to act on behalf of Contractor and will be expected to take part in relevant discussions and decisions. All decisions given to or by the said engineer(s) will be deemed to have been given to or by the Contractor and all ensuring action will be based on these decisions and no claims on the part of the Contractor will be entertained on account of misinterpreted or misunderstood decisions or instructions.
- C. Should the Contractor fail to send engineer(s) for any meeting at which his presence has been requested, all decisions shall be taken and instructions given as if the Contractor had been present and subsequent actions and orders based as aforesaid.

### **1.10 Safety and Accommodation for Contractor's Staff**

- A. The Contractor shall ensure that all safety and welfare measures required under or by virtue of the provisions of any enactment or regulation are strictly complied with.
- B. The Contractor shall provide and maintain suitable and sufficient shelters and mess rooms for his workmen and supervisory staff as are customary and necessary.
- C. The Contractor shall provide at all construction sites sufficient closets or latrines to comply with Government Regulation. They shall be properly screened and maintained in a clean and sanitary state at all times.
- D. Camps for workmen, if provided, shall comply with all relevant Government Regulations and shall be laid out in an approved and orderly manner. Proper provision shall be made for the disposal of all waste and refuse, and there shall be an adequate supply of water for washing, cooking and drinking purposes. Sleeping quarters shall be properly ventilated and lighted, and the whole camp shall be maintained and cleaned at all time to comply with Government Regulations.

### **1.11 Hydrogen Sulphide**

- A. The Contractor is reminded that the existing method of sewage disposal in several parts in Palestine is by septic tanks which allows the liquid fraction to permeate into ground. Previous trench excavations particularly in the inner built up areas have shown high levels of H<sub>2</sub>S gas.
- B. The Contractor shall provide adequate ventilation and efficient apparatus to keep all excavations and trenches free from all gases, whether generated in the strata or arising from any other cause, and he shall take precautions to ascertain that they are in a safe condition before allowing workmen into manholes and sewers.

### **1.12 First Aid Outfits**

- A. The Contractor shall provide and maintain for the duration of the Contract adequate first aid outfits at each construction site. The Contractor shall provide for the transport of serious cases to nearest hospital.

### **1.13 Precautions against Contamination of the Works**

- A. The Contractor shall satisfy the Engineer that all his personnel working on the site are medically fit to be in contact with a public water supply and his personnel shall undergo any necessary medical test to show that they are free from any infectious diseases and are not carriers of any such diseases.
- B. The Contractor shall at all times take every possible precaution against contamination of the Works. The Contractor shall give strict instructions to all persons employed by him to use the sanitary accommodation provided.
- C. Throughout the Contract the Site and all Permanent and Temporary Works shall be kept in a clean, tidy and sanitary condition.
- D. The Contractor shall at all times take measures to avoid contamination of existing water-courses and drains by petrol products or other harmful materials.
- E. The Contractor shall be responsible for making all arrangements for the disposal of wastewater including the disposal of water from the water testing of mains on his own expense. He shall be responsible for obtaining permits from Local Governates prior to such disposals.

### **1.14 Contractor's Yards and Stores**

- A. The Contractor shall make his own arrangements for all yards, weather proof shed stores, workshops, offices, etc., and for all services in connection therewith. The location of all yards, stores, workshop, offices, etc. , shall be agreed beforehand with the Engineer's Representative and shall be such as to avoid obstruction and nuisance to the public.

### **1.15 Archaeological Site and Artifacts**

- A. If, during construction, excavations reveal remains and artifacts of archaeological interest, The Contractor shall immediately inform the Engineer and abide by the Engineer's directions, and shall coordinate and modify the sequence of the execution of the Work. It should be understood that the sole owner of archaeological site and artifacts is the Palestinian National Authority.

### **1.16 Notices of commencement of Work Cooperation with Authorities**

Before commencing any excavation the Contractor shall :

- A. In railway, public highways, footways or verges, give two weeks notice to the Engineer, and shall also give such notices to the authorities as are required by the official regulations before breaking open the road, footway or verge until receipt of approval from the concerned authorities. Cooperation shall be maintained with the Police and Local Authorities regarding the control and diversion of vehicular and pedestrian traffic as may be necessary.
- B. In private lands or roads, give all necessary notices and make timely and reasonable arrangements with the occupiers before entry on the land.
- C. Give notices to the concerned Governorate, the Municipality Tele-communication Corporation the Electric Company / Authority and the police and military forces of work which may affect their cables, manholes, etc. , The Contractor is not allowed to break any cable or manhole without the written permission of their Employer. The Contractor's attention is also draw to his responsibility to comply with Government Regulations.
- D. Before commencing any new section of work the Contractor shall have obtained the formal approval of the above mentioned Authorities. The procedure leading to such approval is described as below :

1. The Contractor shall first discuss with and obtain the approval of the Engineer for the proposed working methods for each section of work.

2. The Contractor shall then submit to the relevant Authorities as agreed with the Engineer notifications of his intention to commence work and give details of his proposal. The Contractor shall modify such proposed working methods if directed by the Authorities. Particular attention shall be given to the following:

- The diversion and control of traffic. Methods for dealing with and the crossing of other services.
- The reinstatement of excavated areas.
- The discharge of water from excavations.
- Public safety.

### **1.17 Access Roads**

- A. The Contractor shall construct and maintain such temporary access roads as he may require for carrying out the Works at his own expense.
- B. Immediately after ceasing to use any of the temporary roads the Contractor shall restore the road to the satisfaction of the Engineer and the responsible Authority or Employer. The provision of this Sub-Clause shall apply also to the shoulders and verges of any existing sealed road used by the contractor affected by his operations.

### **1.18 Restrictions on use of Roads**

- A. The Contractor shall not run tracked vehicles or tracked plant on any public or private road without the written approval of the Engineer and the responsible Authority or Employer and subject to such conditions as each may require.
- B. The Contractor shall observe all weight and dimension restrictions which apply to roads and tracks in Palestine and he shall comply with all reasonable restrictions which may from time to time be imposed by the Engineer, Employer, Police, Ministry of Public Works or responsible Authority.

### **1.19 Site along Pipelines in Roads**

#### **i) General**

- A. Without prejudice to the generality of the Conditions of Contract, the site along with pipelines in roads, unless the road is closed as hereafter provided, shall so far as possible be so limited that in all cases a free passage along such roads shall be maintained for vehicular traffic and pedestrians.
- B. The Contractor shall provide access to all properties including garages fronting on such roads.
- C. The Contractor shall assume and have full responsibility for the adequacy of safety provisions on all streets, roads, private ways and walks affected by his work.

#### **ii) Public Roads**

- A. Notwithstanding requirements stated elsewhere in the Specification, the Contractor shall comply with the additional requirements contained in this Clause whenever carrying out any work in connection with pipelaying in or adjacent to public roads.
- B. The Contractor shall at all times carry out any work in or adjacent to public roads in manner to the approval of the Engineer and the competent Authorities and only at such times and during such hours as may be agreed by the competent Authority.
- C. At no time shall the Contractor commence work in or adjacent to any public road without the prior approval of the Engineer.
- D. The Contractor shall, when working in or adjacent to any public road, cause the least interference possible to the flow of traffic and shall at all times, maintain unimpeded sufficient width of the carriageway, at no time less than 3m, to permit single lane traffic.
- E. The Contractor shall control the flow of traffic past restrictions caused by his operations by means of electrical controlled Flashers positioned ahead of and behind the restricted section of heavy traffic road. The traffic lights shall be to the approval of the Engineer and be lit at all time and for as long any restrictions caused by the Contractor's operations exist. Traffic lights shall be continuously attended by flagmen and the

time interval between light changes shall be capable of adjustment to suit varying patterns of traffic flow. Warning signs shall be posted well in advance of any section of restricted road.

- F. All sections of roadway affected by the contractor's operations shall be bounded by barriers, tapes, bunting or similar means to afford adequate and effective warning such as flagging, lighting, watching and traffic control to all road users. Such boundaries shall in addition be adequately lit by warning lanterns at all times during the hours of darkness.
- G. The Contractor shall at no time string pipes on the carriageway of any public road.
- H. The Contractor shall arrange his work in or adjacent to public roads in such a way that at no time the length of road restricted by his operations exceeds 100 meters in urban areas and 500 meters in rural areas.

## **1.20 Closing of Roads, Traffic Diversion and Control**

### **i) Closing of Roads**

- A. The Contractor shall not close any road unless the Authority having charge of the road surfaces shall have previously given the appropriate notice or made the appropriate order and without the Contractor having first obtained the written consent of the Local Authority to close the same. In the event of such consent being refused, the Contractor shall have no claim for any additional payment. In the event of such consent being given, the Contractor shall provide, fix and maintain all warning signs and diversion notices as may be required by the said Authority and by the Engineer.

### **ii) Traffic Diversions**

- A. Traffic diversions shall be planned by the Contractor with the Engineer, the Traffic Section of the Public Works Directorate and the Traffic Directorate of the Ministry of the Interior. No diversion shall be implemented without the written consent of the Engineer. Access to a closed road shall be made available to any vehicle of the emergency services.

### **iii) Traffic Signs**

- A. The Contractor shall provide, erect and maintain on the Site and such locations on the approaches to the Site, as may be required by the Traffic Directorate and / or the Engineer, all traffic signs and traffic control signals necessary for the safe direction and control of traffic. This shall apply whether the Site is in or immediately adjacent to the carriageway such that normal passage of traffic is affected.
- B. The size of all such signs and the lettering thereon shall be approved by the Engineer before erection of the signs. All signs shall have directions written in both Arabic and English and shall carry direction arrows where appropriate. The signs shall be reflectorised or adequately illuminated by night in a manner approved by the Traffic Directorate and/or the Engineer and kept clean and legible at all times. The Contractor shall reposition, cover or remove signs as required during the progress of the Works.
- C. Wherever single file traffic is necessary on a highway by reason of the construction of the Works, the Contractor shall provide and maintain a minimum carriageway width of 3 meters or wider where necessary as so instructed by the Engineer.

## **1.21 Site Cleanliness**

- A. The Contractor shall make every effort to keep his site in a clean and orderly manner. He shall not deposit his builders' refuse indiscriminately but shall arrange for all waste to be transported to an authorized pit. He shall not deposit his refuse into trenches in backfilling.

- B. Public highways services, streets, paved paths, passages, pavements, etc., must be kept clean and free of spoil and rubbish and must be brushed and washed as required by the Engineer.
- C. If the Contractor fails to keep his site clean after receiving the Engineer's written warning notice, then the Engineer will instruct a third party to carry out the work and the costs shall be recovered from the Contractor through the Contract.

### **1.22 Operation of Existing Utilities**

- A. The existing utilities must be kept in continuous operation throughout the construction period. No interruption will be permitted which adversely affects the level of service provided.
- B. Provided permission is obtained from Employer and Engineer in advance, portions of the existing utilities may be taken out of service for short periods corresponding with periods of minimum service demands. Such permission will not relieve the Contractor of any of his responsibilities under the Contract.

### **1.23 Connection to Existing Sewerage Systems :**

- A. During the course of the Contract it shall be necessary to make connections to the existing system by making connections to existing manholes. The Contractor's attention is drawn to the high levels of H<sub>2</sub>S gas existing in commissioned manholes and live sewers (sewer, manhole or other chamber in which sewage or sewage gas can enter) and the resulting toxic environment created.
- B. Notwithstanding the specified requirements for safety, health, welfare and ventilation, the Contractor shall not permit any employee to enter "live" sewers without the express permission of the Engineer in writing and no entry to a live sewer shall be effected without :
  - 1. Gas detector
  - 2. Rope for each man entering the sewer.
  - 3. Helmet for each man entering the sewer.
  - 4. Safety harness for each man entering the sewer.
  - 5. Safety lamps for each man entering the sewer.
- C. The following equipment being available at the point of entry :
  - Oxygen breathing apparatus in working order.Below is a summary precautions to be taken :
  - Ventilate the sewer by removing upstream and downstream manhole covers.
  - Take gas tests.
  - Do not use naked lights. This includes smoking.
  - Never less than 2 men to be left at point of entry.
  - Use of Glovers
- D. The following equipment standing - by with qualified operator :
  - Oxygen breathing apparatus in working order.Below is a summary precautions to be taken :
  - Ventilate the sewer by removing upstream and downstream manhole covers.
  - Take gas tests.
  - Do not use naked lights. This includes smoking.
  - Never less than 2 men to be left at point of entry.
  - Use of Glovers
- E. Where a sewer is to be connected to an existing manhole, core drilling shall be used. The Contractor shall carefully drill in, divert the flow in a satisfactory manner or dispose the flow to an approved site by the local Government, perform the connection, provide the necessary temporary and permanent plugs, make any necessary adjustments in the manhole benching, clean up and repair all items disturbed or damaged including the protective systems. Work in connection to existing manholes shall be subject to the approval of the Engineer.

### **1.24 Existing Septic Tanks**

- A. Where septic tanks are connected or located in the street right -of-way interfere with the installation of sewers, appurtenances and / or building connections, the Contractor shall take whatever action is required to drain the tank. During the progress of the work, the service shall be maintained continuously in use and facilities shall be provided to pump incoming sewage from the tank and dispose of it to an approved site by the Local Government . Sewage shall not be allowed to run into the trench nor into storm sewers nor any portions of the sanitary sewer system that have not been tested or which cannot drain to the existing sanitary sewer system.
- B. In case of sanitary sewer construction, portions of the tank shall be removed as required for the installation of the sewer, appurtenances and /or building connection pipe. In all cases the top slabs of septic tanks shall be completely removed, the tank walls shall be filled with compacted material conforming to the requirements of section 2.
- C. All existing septic tanks in the street right-of-way shall be drained and backfilled whether they interfere with the sewers or not. The Contractor is responsible to visit the Site and estimate the cost and the number of septic tanks.

### **1.25 Installation of Sewer Pipes Through Septic Tanks**

- A. Pipes which must pass through septic tanks shall be supported on granular bedding, concrete block, concrete fill, or reinforced concrete beams as detailed on the Drawings, to provide uniform and unyielding support over the length of pipe. Where concrete beams are used they shall be adequately seated on undisturbed ground on either side of the septic tank so that the pipe or channel support is independent of the septic tank structure. Pipe or expansion joints shall be located at each end of the support to provide flexibility to accommodate differential movement between adjacent pipes or channels with different bedding conditions. All installed pipes, expansion joints and fittings shall be a metal material as specified.

### **1.26 Location of Existing Subsurface Structures and Utilities**

- A. Before beginning excavation operations, the Contractor shall contact the specified Departments and Authorities and notify them of his intention to begin excavation operations.
- B. The Contract Drawings may show certain utility or other structures or facilities believed to exist in the working area, the exact location of which may vary from the locations indicated. All other structures or facilities may not be shown. The Drawings do not show all existing subsurface structures or utilities.
- C. It shall be the responsibility of the Contractor to determine the exact location of such pipeline, subsurface structures and / or utilities ahead of his Work by exploratory ,excavation or other means and to take suitable precautions to prevent damage to them and to prevent interruption of the services which such facilities provide. If they are unintended broken or damaged, they shall be restored by the Contractor or the appropriate utility at the Contractor's expense.
- D. The Contractor will be paid for all works necessary to complete exploration and relocation of subsurfaces and/or utilities by each linear meter of the measured pipeline.
- E. Where necessary, the Contractor shall use hand tools to excavate test pits prior to excavation to determine the exact locations of existing utilities. It shall be the responsibility of the Contractor to make such explorations sufficiently in advance of construction to enable the Engineer to approve modifications, if any, to be made to the pipeline, structure or conflicting utility. The Contractor shall obtain the permission of the Engineer before



commencing any test pits and shall fence, mark and protect them, as required by the Engineer. Test pits shall be refilled by hand as soon as practicable after the necessary information has been obtained.

- F. As the excavation approaches sewers conduits, cables or other underground facilities, and with care the excavation shall be continued by means of hand tools. Where necessary, the Contractor shall provide temporary support for the existing utilities to prevent damage during his operations. Notwithstanding these provisions, if damage to existing utilities results from the Contractor's operations, such damage shall be repaired without delay by the Contractor or such repairs shall be borne by the Contractor.
- G. If damage to existing utilities causes disruption to Contractor's Schedule of Work by delaying Work in the area of such damage, the Contractor shall readjust his Schedule, methods of working and resources so that critical dates in the Schedule for the completion of the Contract are not affected.
- H. In case of pipelines, subsurface structures and /or utilities encountered in the work coincide with the pipe line route, the Engineer shall have the authority to change the plans and order a deviation from the line and grade, or arrange with the Employers of the existing structures for removal, relocation or reconstruction of the obstruction following the procedures of the Employer at the Contractor's expense.
- I. If the change in plans results in change of the length of pipes to be executed by the Contractor, such altered work shall be done on the basis of payment to the Contractor for extra length or credit to the Employer for less work. This payment will be made for extra exploration and relocation of structures and utilities, pipes, valve chambers, excavation, backfilling and depth of line due to these changes.

### **1.27 Signboards**

- A. The Contractor shall provide, erect and maintain signboards having messages written in both Arabic and English languages, as prescribed by the Authority and installed at each site of work and at the office, or at such other places as directed by the Engineer, and remove the same on completion. The sign boards shall generally show the following :

- Name of Authority
- Name of Contractor
- Name of Work
- Date of Commencement
- Date of Completion

- B. The minimum size of signboards shall be 1.0 X 1.5 meters, or as specified.

### **1.28 Lines and Grades**

- A. The Contractor shall keep the Engineer informed, a reasonable time in advance, on the times and places at which he intends to do work, in order that lines may be established and necessary measurements for record and payment made with a minimum of inconveniences to the Engineer or delay to the Contract. The Contractor shall have no claim for damages or extension of time account of delays in the giving of lines and grades, making record measurements or destruction of such marks and the consequent necessity for replacement.
- B. The Engineer will furnish the Contractor with such basic lines as he, the Engineer, deems necessary, but this shall not be construed to mean all lines, elevations and measurements. It shall be the Contractor's responsibility before commencing any section of the Work to locate the permanent bench marks to be used. The Contractor shall refer all temporary bench marks thereto.
- C. The Contractor shall be responsible for the stake-out survey for construction purposes and the replacement of monuments and property, markers disturbed by the work. The survey shall proceed in advance of the

construction at a rate satisfactory to the Engineer. The Contractor shall keep the Engineer fully informed as to the progress of the stake-out survey.

- D. The exact position of all work shall be established from control points which are given or modified by the Engineer. Any error, apparent discrepancy or omission in the data shown or required for accurately accomplishing the stake-out survey shall be referred to the Engineer who shall take whatever corrective measures be deemed necessary.
- E. The Contractor shall be responsible for the accuracy of his work and shall maintain all reference points, stakes, etc., through the life of the Contract. Damaged, destroyed or inaccessible reference points, bench marks or stakes shall be replaced by the Contractor (existing or new control points) that will be or are destroyed during construction shall be re-established and all references ties recorded therefore shall be furnished to the Engineer.
- F. All computations necessary to establish the exact position of the work from control points shall be made and preserved by the Contractor. All computations, survey notes and other records necessary to accomplish the Work shall be neatly prepared and made available to the Engineer upon request or furnished upon Contract completion.
- G. All labour, instruments, equipment, stakes and other material necessary to perform the Work shall be provided by the Contractor.
- H. All stakes used shall be of a type acceptable to the Engineer, clearly and permanently marked, so as to be legible at all times. It shall be the Contractor's responsibility to maintain these stakes in their proper position and location at all times. Any existing stakes or markers defining property lines and survey monuments which may be established during construction shall be properly tied in to fixed reference points before being disturbed and accurately rest in their proper position upon completion of the Work.
- I. The Engineer may check all or any portion of the stake-out survey work or notes made by the Contractor and any necessary correction to the Work shall be immediately made. Such checking by the Engineer shall not relieve the Contractor of any responsibilities for the accuracy or completeness of his work.

### **1.29 Protection of Works**

- A. The Contractor shall take every care to prevent damages to the Works from whatever cause and shall ensure that adequate protection is given to all Works from activities of following trades and nominated sub-contractors. Vulnerable parts of the Work particularly liable to damage, shall be protected as may be reasonable required by the Engineer's Representative.
- B. The Contractor shall keep all persons (including those employed by sub-contractors) under control and within the boundaries of the Site. He will be held responsible for the care of the existing premises and of the Works generally until their completion, including all work executed and materials, goods and plant (including those of sub-contractors and suppliers) deposited on the Site; together with all risks arising from the weather, carelessness or of work people, damage or lost by theft or any other cause; and he shall make good at his own expense, all such damage and loss.
- C. The Contractor shall keep the Works well drained until the Engineer certifies that the whole of the Works is substantially complete and shall ensure that so far is practical, all Work is carried out in the dry weather. Excavated areas shall be kept well drained and free from standing water.
- D. The Contractor shall construct, operate and maintain all temporary dams, watercourses and other Works of all kinds including pumping and well point de-watering plant that may be necessary to exclude water from the Works while construction is in progress. Such temporary Works and plant shall not be removed without the approval of the Engineer's Representative.

- E. Notwithstanding of any approval by the Engineer of the Contractor's arrangements for the exclusion of water, the Contractor shall be responsible for the sufficiency thereof and for keeping the Work safe at all times particularly during any floods and/or making good at his own expense any damage to the Works including any that may be attributable to flood. Any loss of production of additional costs of any kind that may result from floods shall be at the Contractor's own risk.

### **1.30 Materials, Goods and Workmanship**

#### **i) General**

- A. Materials, goods and workmanship shall be of the best quality of their respective kind. The Contractor shall carry out every thing necessary for the proper execution of the Works, whether or not shown on the Drawings or described in specifications.
- B. Work for which provisional quantities are specified will be measured and dealt with in the manner stated in the conditions of Contract for provisional sums.

#### **ii) Customs and Local Dues**

- A. All state dues, tolls rates, fees and charges in connection with the works shall be deemed to be included by the Contractor in his Contract Unit Rates.

#### **iii) Specified Manufacturer's Products**

- A. Manufacturer's name or catalogue number, if shown in the specification or indicated on the Drawings, are given only for indicative purposes and for general reference only. It shall be understood that the actual material supplied shall meet the requirements of the specifications. If necessary, the material specified under such manufacturer's name or catalogue indicated for reference, shall be modified under the direction of the Engineer.
- B. Provided always the such modified material shall meet the requirements of the specified material together with the requirements of other materials specified for other trades in these specifications.
- C. Any modification under such conditions shall not give the right to the Contractor to claim against any loss or extra cost incurred.

#### **iv) Alternative Materials**

- A. Should the Contractor wish to offer alternative items or materials to those specified, he shall supply details of such alternatives together with details of any reduction in the Contract price should the alternative be allowed to be substitute for the specified items of materials. All offered alternatives shall comply fully in all respects with the specifications of the particular items or materials. Acceptance or refusal of such alternatives will be entirely at the discretion of the Engineer.
- B. If during the course of the Contract certain materials or items required for use in the Works should be unobtainable, despite the best effort of the Contractor, he may offer for the approval of the Engineer alternative materials or items, provided that they possess the minimum requirements of the originally specified material.
- C. In the event of acceptance of any alternative materials or items, a suitable price reduction shall be made in respect of any decrease in value but no price addition shall be made in respect of increase in value.

- D. In the event of refusal of any alternative materials or items the Contractor shall not be relieved of any of his obligations under the Contract and shall be solely liable for any delay or loss occasioned by his failure to provide the material or items as specified.

**v) Imported Materials**

- A. The Contractor is required to produce documentary evidence that all imported materials or items have been ordered shortly after the Site is handed over for the commencement of the Works. This means materials or items which have to be ordered from abroad. As soon as orders have been placed, copies of such orders shall be submitted to the Engineer.
- B. Consequently, no claim will be considered for extension of the Contract Period due to non-availability of materials unless for force measures as decided the Engineer.

### **1.31 Programme and Methods of Working**

**i) General.**

- A. The Contractor shall submit to the Engineer full details of his proposed construction Programme within the period stipulated in the Contract. He shall also submit details both of the construction plant and labour force which he proposes to employ and shall broadly describe his proposed construction methods.
- B. The details of the construction plant force shall include the make, type, capacity or rating and the number of units. Details of the labour force shall include senior staff, trade of specialist categories indicating the proportion of local labour which the Contractor expects to employ and shall show the variation in staff and labour levels and their distribution throughout the duration of the Contract consistent with the programme.

**ii) Details of Work Programme:**

- A. The Contractor shall furnish the following agreed details of his work programme to the Engineer and to local Authorities responsible for traffic and traffic control at the times and in the manner detailed below.
- a) Within two weeks of the Order to Commence, the Contractor shall submit to the Engineer an overall programme of work indicating the period of executing each section of work in or along side highways including details of anticipated road diversions. At the same time he shall provide a more detailed programme describing his proposal for the first month of work.
- b) Every month, the Contractor shall submit to the Engineer and the concerned Authorities a detailed programme describing the areas in which he proposes to operate for the following two months period including descriptions of proposed road diversions.

**iii) Sequence of Construction :**

- A. When preparing the programme of works as specified, the Contractor shall take account of the priority order described for various activities of the Work.

### **1.32 Continuous Working**

- A. If in the opinion of the Engineer, it is necessary for the safety of the Works or for any other reason, the Contractor shall carry out any part of the Works continuously by day and by night when so instructed in writing by the Engineer.

### **1.33 Limits and Restrictions to Working Site**

- A. Generally, working sites shall be confined by physical restrictions and the maintenance of accesses and traffic flow. The Contractor shall agree on the extent of his working areas with the concerned Authorities and the Engineer.

### **1.34 Site Progress Meetings**

- A. During the course of the work, Site Progress meetings shall be held at regular intervals at least once every week in the presence of the Engineer for the purpose of co-ordinating the Contractor's Works and to ensure that full compliance with the various Site meetings will be recorded, copies will be distributed to all persons concerned and full effect shall be given to all instructions contained herein.
- B. Prior to such meetings the Contractor shall give to the Engineer's Representative details in writing of that portion of the Works he proposes to construct during the coming two weeks with details of the plant and methods he proposes to employ. These proposals shall be discussed at the meeting and no work based on such proposal shall proceed without the approval of the Engineer's Representative.
- C. The Contractor shall have no claim against the Employer for costs incurred by him in changing the method of working or in the provision and use of other additional plant.

### **1.35 Cancellation Due to Slow Progress**

- A. If the Engineer shall be of the opinion that having regard to the state of the Works at any time, the Contractor will be unable to complete any section of the Works by the time specified or by such extension thereof as he may be entitled to, under the Contract and the Contractor has failed to carry out steps and to expedite the work in accordance with the Conditions of Contract or, if the Engineer is of the opinion that such steps are inadequate, the Engineer may after written warning notice, by written order, omit the whole or any part of the uncompleted work included in that section. The Employer shall be then, at liberty to execute such omitted work by his own workmen or by other contractors. If the cost of such omitted or incomplete work shall exceed the sum which would have been payable to the Contractor on due completion of the said work, then the Contractor shall, upon demand, pay the Employer the amount of such excess and it shall be deemed debt due by the Contractor to the Employer and shall be recoverable accordingly.

### **1.36 Other Construction Activities**

- A. The Contractor shall note that other works, might be constructed in the Site of Works. He shall co-operate with the construction of such works in organising their respective contracts so as to cause minimum of interference to each other and to the public. No claims resulting from such co-operation shall be entertained by the employer except as stipulated in the Conditions of Contract.

### **1.37 Safety of Adjoining Existing Buildings**

- A. The Contractor shall take all necessary precautions during the excavation for the Works particularly those excavations which are adjoining existing building and shall protect such buildings from damage or collapse by means of temporary or permanent shoring, strutting, sheet piling or underpinning or excavation in short length and/or other methods as he deems fit. Also, he shall properly support all foundations, trenches, walls, floors, etc...., affecting the safety of the adjoining existing buildings.
- B. The Contractor shall alter, adopt and maintain all such Works described above for the whole period of the Contract and shall finally clear away and make good all damages done.

- C. The construction and efficiency of the shoring, underpinning, strutting, etc. ... , for the purpose for which it is erected shall be the responsibility of the Contractor. Should any subsidence or any other damage occur due to the inefficiency of the shoring, underpinning, strutting, etc... , or any other support provided, the damage shall be repaired by the Contractor at his own expense and responsibility.
- D. The shoring, strutting, piling, etc.... , shall be executed in such a manner as to cause as little inconvenience as possible to adjoining Employers or the public and the Contractor shall be responsible for negotiating with the adjoining Employers the means to safeguard their property and for the use of any portion of their land for the purpose of executing the excavations and no claims submitted on this ground will be entertained.
- E. The Contractor shall be held solely responsible for the safety of the adjoining existing buildings, the sufficiency of all temporary or permanent shoring, underpinning, strutting, piling, etc....,
- F. The Contractor shall keep the Engineer informed as to the manner in which he intends to proceed with the execution of the excavations, submit his proposed methods of shoring, strutting, etc., and obtain his approval, such approval if given shall not absolve the Contractor of his responsibility under this clause.
- G. The Contractor shall save harmless and indemnify the Employer in respect of all claims, demands, proceedings, damages, costs, charges and expenses whatsoever arising out of or in relation to any such matters in so far as the Contractor is responsible under this clause.

### **1.38 Tests for Water Tightness of Structures**

- A. The tests will be applied on structures for projects within high water table areas. Other projects will be evaluated by the Engineer for the necessity of such tests.
- B. Sewage retaining structures shall be capable of withstanding the following tests for water tightness:
- C. When ordered by the Engineer and before backfilling, the structures shall be filled with water by the Contractor at rates and to the depths ordered by the Engineer and kept filled for one week.
- D. The water used need not be equal to normal drinking water but the source of the water shall be approved by the Engineer.
- E. The structure when filled shall satisfy the test if at the end of one week no leakage is apparent.
- F. Upon completion of the test the Contractor shall empty the structures and dispose satisfactorily of the contents. He shall clean the structures and any equipment therein of all deposits left by the testing water.
- G. The tests referred to above, shall be performed at the Contractor's expense and shall be considered incidental to the Contractor.

### **1.39 Inspection**

#### **i) Inspection of Site**

- A. The Contractor shall be deemed to have inspected and examined the Site and its surroundings and to have satisfied himself before submitting his Tender as to all matters relative to the nature of the site, details and levels of existing services, the quantities and nature of the work and materials necessary for the completion of the works, the means of access to the Site and the accommodation he may require, and in general to have himself obtained all necessary information as to risks, and other climatic hydrological and natural conditions or such contingencies which may influence or effect his Tender. No claim will be entertained in the connection.

## **ii) Shop Inspection and Testing**

- A. All materials furnished by the Contractor shall be subject, at the discretion of the Engineer, to inspection, testing, and approval at the plant of the Manufacturer.

## **iii) Inspection of Adjacent Structures**

- A. Buildings and other structures in such close proximity to the trenches that they may be damaged by excavation and other works shall be inspected before work is commenced. All parties concerned shall be summoned to the inspection by the Contractor. The inspection shall be made by the Engineer and the Contractor together, and the Contractor at his own expense, shall work out an inspection report. The report shall describe the conditions of the buildings or plants in question. Any failure or damage caused by the excavation, shall be repaired and maintained by the Contractor at his own expense without delay.

## **iv) Final Inspection of Works**

- A. Upon the request of the Contractor items that are completed will be finally inspected by the Engineer. The Contractor shall hereby provide at his own cost all facilities and labour required for the proper inspection all work will be checked so as to meet with the specifications given in the Contract Documents, all streets in the contract area may be inspected by the municipality and test may be carried out to verify that the surface restoration has been completed in accordance with the Specification of the Municipality and the Ministry of Public Works.
- B. All restoration work not accepted by the Municipality, whether due to poor workmanship, settlement of trenches or damage to asphalt surface by the Contractor's heavy equipment shall be rectified by the contractor at his own expense before the provisional handing over certificate is issued.

## **v) Inspection During Maintenance Period**

- A. The Engineer shall give the Contractor due notice of his intention to carry out any inspections during the period of maintenance and the Contractor shall thereupon arrange of all necessary equipment labour, etc., and for a responsible representative to be present at the times and dated named by the Engineer. This representative shall render all necessary assistance and take note of all matters and things to which his attention is drawn by the Engineer.

### **1.40 Late Submission For Testing**

- A. It shall be the Contractor's responsibility to ascertain which materials and articles are required to be tested and to present such materials and articles or samples or specimens thereof for testing. Should there be doubt as to whether any material or article is required for testing the Contractor shall seek clarification from the Engineer and the Contractor will be entitled to no claim whatsoever for delay or any other cause arising from the rejected of materials or articles which the Contractor omitted to submit for testing.
- B. It shall further be the Contractor's responsibility to prepare samples and specimens and submit for testing well in advance of the time the materials or articles will be required for use. The Contractor shall not be entitled to any compensation nor shall any claim be accepted by the Employer in respect of delay, inconvenience, damage, standing time or any other cause whatsoever, arising from or consequent on late submission of materials or articles for testing.

### **1.41 Shop Drawings**

- A. The Engineer shall have authority to order at any time and the Contractor agrees to provide at his own expense any number of shop drawings which, in the opinion of the Engineer, are necessary for the proper

execution of a specified work. The Contractor shall not proceed with the above mentioned work unless these shop drawings are approved by the Engineer.

### **1.42 “As-Built” Drawings**

- A. All prints of the “Shop Drawings” , where required, shall be corrected by the Contractor and submitted to the Engineer for approval as the Works proceed. Upon the completion of the Works, the Contractor shall prepare a complete set of “As Built” Drawings for the project as executed, including tie-ins, presented on a computerized electronic form, and submit them to the Engineer for approval. When approved by the Engineer, the Contractor shall submit a digital copy of the specified format for each project and six copies of all Drawings duly marked “As-Built”. The final payment shall not be made except for the actual Works that have been completed in accordance with the Specifications and have been duly presented on the “As-Built” Drawings.
- B. The Contractor shall not be entitled to any extra payment or extension of time for the correction, preparation and supplying of the mentioned and transparencies.

### **1.43 Bill of Quantities and Bid Prices**

- A. The Contractor shall before pricing the Work check all Drawings, Specifications and Bill of Quantities and satisfy himself by measurement, enquiry or otherwise as to their accuracy.
- B. It shall be the responsibility of the Contractor to satisfy himself as to the Correctness of the Quantities of materials to be supplied and amount of works to be carried out before submitting his bid price.
- C. The Contractor shall notify the Employer of any omissions, errors or discrepancies found in the Specifications, Drawings, or Bill of Quantities prior to submitting his tender and shall include in his Bid Price for the particular section of the Works described in the Bill of Quantities and the cost of any materials and works missing or which have been over-looked in the preparation of the Tender Documents and which are necessary for the proper completion of work.
- D. Omissions from the Drawings or Specifications or the incorrect description of details of work which are evidently necessary to carry out the intent of the Drawings and Specifications, or which are customarily performed, shall not relieve the Contractor from rectifying such omissions and details of work, but they shall be performed as if fully and correctly setforth and described in the Drawings and Specifications.
- E. The Contractor shall, after a thorough and careful study of all the required works comprised in the various sections of the several Documents of the Contract, make an assessment of the amount of all the works comprised and shall quote in the Bill of Quantities a Bid Price for each of the various items of Works described, which price shall be binding subject to the relative Clauses of the Contract.
- F. The Bid Prices inserted in the Bill of Quantities are the full inclusive of the value of the Works described under the several items and shall cover, by way of illustration but not limitation, the cost of all labour, subsistence, traveling, materials, fittings, temporary works, constructional plant, watching and lighting, overhead charges and any other expenses whatsoever together with all risks, liabilities and obligations setforth or implied in the Contract Documents. The Bid Prices shall also include for all ancillary and other work facilities and services relating to the construction of the sewerage system, cleaning and tidying of the Site on completion and all that is required to hand over the Works and surrounds complete in every respect and ready for immediate use in accordance with the Drawings, Specifications, Bill of Quantities and other Tender Documents to the full satisfaction of the Engineer.



### **1.44 Suppression of Noise and Pollution**

- A. The Contractor shall make every reasonable endeavor both by means of temporary Works and by the use of particular plant or silencing devices to ensure that the level of noise or pollution resulting from the execution of the Works does not constitute a nuisance.
- B. The Contractor shall take all such precautions as may be necessary in the conduct of the work to avoid water pollution, air pollution, noise pollution harmful to health, spreading of plant diseases and pests or damage to natural resources or the environment, all as is consistent with good practice and as required by applicable laws, ordinances and regulations or lawful orders or authority having jurisdiction.

### **1.45 Protective Equipment and Clothing**

- A. The Contractor shall provide and maintain all necessary protective and safety equipment and clothing for the operative and Site staff.

### **1.46 Cleaning Up**

- A. On or before the completion of the work, the Contractor shall, unless otherwise especially directed or permitted in writing, tear down and remove all temporary buildings and structures built by him; shall remove all temporary Works, tools and machinery or other construction equipment furnished by him; shall remove, acceptably disinfect, and cover all organic matter and material containing organic matter and in, under and around privies, houses and other buildings used by him; shall remove all rubbish from any grounds which he has occupied and shall leave the roads and all parts of the premises and adjacent property affected by his operation in a neat and satisfactory condition.
- B. The Contractor shall restore or replace, when and as directed, any public or private property damaged by his work, equipment, or employees, to a condition at least equal to that existing immediately prior to the beginning of operations. To this end the Contractor shall do as required all necessary highway or driveway, walk and landscaping work. Suitable materials, equipment and methods shall be used for such restoration.
- C. The Contractor shall thoroughly clean all materials and equipment installed by him and his subcontractors and on completion of the work shall deliver it undamaged and in fresh and new appearing condition. All mechanical equipment shall be left fully charged with lubricant and ready for operation.

### **1.47 Permits, Licenses and Fees**

- A. Unless otherwise indicated in these Contract Documents, the Contractor shall obtain and pay for all construction permits and licenses. Employer shall assist contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work. contractor shall also pay all charges of utility service companies for connections to the work.

## SECTION 2 - EARTHWORKS

### 2.1 Scope of Work

- A. This section covers trenching and backfilling work and shall include the necessary clearing, grubbing and preparation of the site; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation and disposal of all excavated material; all necessary sheeting, shoring and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; backfilling; pipe embedment; surfacing and grading; and other related work.

### 2.2 Site Preparation

- A. Prior to commencing any excavation work, the Contractor shall establish a horizontal and vertical survey, record existing ground elevations and stake the location of trenches to be excavated.
- B. The Contractor shall prepare the site for construction by clearing, removing and disposing of all items not indicated on the Drawings to remain or so defined by the Engineer.
- C. The Contractor shall obtain relevant excavation and road cutting permits as required to commencing work.

#### i) Existing Subsurface Structures and Utilities

- A. For all works required to deal with existing subsurfaces and utilities refer to General Section of these Specifications.

#### ii) Clearing, Grubbing and Grading

- A. The Contractor shall perform the clearing and grubbing (if any), of top soil consisting mainly of loose soil, vegetable and organic matters, drift sand, unsuitable soil and rubbish by scarifying the areas to be excavated and sidewalks to a minimum depth of 300 mm from the natural ground level. All materials resulting from the above operations shall be removed from the site, loaded and transported and off loaded, spread and leveled to approved dumps as directed by the Engineer.
- B. The Contractor shall include for grading the route to provide access for his equipment and personnel, executing all cuttings to remove the high point of rises in terrain and in all respects prepare the route for pipe laying operations, all in accordance with the requirements of good pipeline construction practice.

### 2.3 Setting-Out

- A. The Contractor shall stake-out the work as shown on the Drawings and secure the Engineer's approval of his stake-out before proceeding with construction. If, in the opinion of the Engineer, modification of the line or grade is advisable before or after stake-out, the Engineer will issue detailed instructions in writing to the Contractor for such modification and the Contractor shall revise the stake-out for further approval in accordance with the relevant Clause of the Conditions of Contract.

### 2.4 Excavation

- A. The Contractor shall perform all excavation true to lines, widths and depths shown on the Drawings or to such further lines, depths or dimensions as may be directed by the Engineer.
- B. Excavation work will be classified according to the quality of the material to be excavated. In three classes as follows

1. Excavation in Rock
  2. Excavation in sand
  3. Excavation in mixed soil
- C The soil classes in every section of the pipeline will, if necessary, be determined by the engineer on the basis of the following definitions:
- D **Excavation in Rock** shall include the removal of hard and solid rock in continuous layers or boulders that cannot be broken up by ordinary excavating equipment including rooter, and which necessitate the use of pneumatic tools or wedges for loosening and removal.
- E **Excavation in Sand** shall include excavation in loose or dense sand , such as drifting sand(dunes).
- F **Excavation in mixed soil** shall include the removal of all material that cannot be classified as rock or sand as defined above(Heterogeneous Soil).
- G Everything said in the specification with regard to the execution of excavations, disposal of excavated materials, etc. shall equally apply to rock, sand and common excavation, unless otherwise stated.

#### **i) Road along the line .**

- A Wherever necessary the Contractor shall prepare a road along the line at such distance from the line that the traffic on the road will in no way interfere with pipelaying work. The Contractor shall also prepare access roads from the highway or other public roads to the said access road.
- B The road along the line and the access roads shall permit the normal movement of trucks and other vehicles and all equipment and plant required for the execution of the works.
- C The employer's employees shall at times have the use of the roads prepared by the Contractor, free of charge.
- D The Contractor shall maintain the road along the line and the access roads in a good and serviceable condition and shall make all repairs that may be necessary during the whole period of construction.

#### **ii) Excavation to reduce levels.**

- A Wherever shown on the drawings, the Contractor shall reduce the ground level on the trench site, prior to commencement of trench excavation. Before starting excavation for reducing of levels the Contractor shall move the marking of the alignment to such a distance that the marks will not be destroyed and will not interfere with the execution of the work.
- B Excavation for reducing levels shall be done to the lines and levels shown on the drawings. Where the depth of excavation is not so shown it shall be done to a line parallel to the trench bottom in the section concerned.

#### **iii) Storing of Suitable Excavated Material**

- A During excavation, materials suitable for backfill and fill will be stockpiled on the site at sufficient distance from the sides of the excavation to avoid over-loading and prevent cave-ins or mixing with the concrete during the construction of foundation.

#### **iv) Disposal of Unsuitable and Surplus Excavated Material**

- A Upon the order of the Engineer, all unsuitable and surplus materials shall be immediately removed, loaded and transported off the Site area by the Contractor to approved dumps and he shall abide by the relevant local regulations.

### **v) Unauthorized Excavation**

- A If the bottom of any excavation is taken out beyond the limits indicated or prescribed, the resulting void shall be backfilled by well graded material at the Contractor's expense with thoroughly compacted to an acceptable proctor as directed by the Engineer, if the excavations are for a structure or a manhole, then the void should be filled by class B150 concrete.

## **2.5 Removal, Restoration and Maintenance of Surface**

### **i) Removal of Pavement**

- A The Contractor shall remove pavement and road surfaces as a part of the trench excavation, and the volume removed shall depend upon the width of trench specified for the installation of the pipe and the width and length of the pavement area required to be removed for the installation of valves, fittings, valve chambers, thrust blocks, manholes, or other structures. The width of pavement removed along the normal trench for the installation of the pipe shall not exceed the top width of the trench specified by more than 200 mm on each side of the trench. The widths and lengths of the area of pavement removed for the installation of valves, fittings, valve chambers, thrust blocks, manholes, or other structures shall not exceed the maximum linear dimensions of such structures by more than 300 mm on each side. Wherever, in the opinion of the Engineer, existing conditions make it necessary or advisable to remove additional pavement, the Contractor shall remove it as directed by the Engineer but shall receive no extra compensation therefore. The Contractor shall use such methods, either drilling or chipping, as will assure the breaking of the pavement along straight lines. The cut must be sharp and approximately vertical. The Engineer's representative may require that the pavement be cut with asphalt cut machine without extra compensation to the Contractor.

### **ii) Restoration of Damaged Surfaces and Property**

- A If any pavement, trees, shrubbery, fences, poles, or other property and surface structures have been damaged, removed, or disturbed by the Contractor, whether deliberately or through failure to carry out the requirements of the contract documents, state laws, municipal ordinances, or the specific direction of the Engineer or through failure to employ usual and reasonable safeguards, such property and surface structures shall be replaced or repaired at the expense of the Contractor. If the Employer specifies that the replacements or repairs shall be made by the Contractor, he shall replace or repair and restore the structures to a condition equal to that before the work began and to the approval of the Engineer and shall furnish all incidental labour and materials.

## **2.6 Trench Excavation**

### **i) General**

- A The minimum trench width at the bottom shall be equal to the external pipe diameter plus 500 mm provided that the minimum clearance between the installed pipe and the trench side shall not be less than 250 mm. The rest of the trench, unless otherwise shown on the drawings or instructed by the Engineer, shall be excavated with approximately vertical sides as much as possible.
- B The trench width at the ground surface shall be excavated as narrow as practicable but may vary with, and depend upon its depth and the nature of the ground encountered.

- C Trenches shall be of such extra width, when required, as will permit the convenient placing of timber support, sheeting and bracing and handling of specials.
- D The graded material bedding under the pipe shall be not less than 150 mm thick in any point and as shown on the drawings and as directed by the Engineer.
- E The trench depth shall give the required minimum cover over the pipe as specified.
- F The trench bottom shall be straight and even so as to provide a good support for the pipe on its entire length and shall be free of roots, stones, lumps and other hard objects that may injure the pipe or its coating. The excavated material shall be placed alongside the trench in such a manner as not to interfere with the work and to prevent its falling down into the trench.
- G Where welds or joints of pipes and accessories are required to be done in the trench, it shall be widened or deepened to the usual enlarged dimensions or as directed by the Engineer so as to easily permit the proper execution of all welding and fixing works at all their stages, coating repairs, and thorough inspection of all these operations.
- H Separate excavations are to be made for manholes, pipe junctions, etc.
- I No more trench shall be opened in advance of pipe laying than is necessary to expedite the Work. 100m shall be the maximum length of open trench within urban areas and 500m in rural areas.
- J Hand excavation must be applied where existing cables, water mains, sewers, etc., cross or are in the main roads where traffic is likely to be unreasonably dislocated by use of machine or where instructed by the Engineer. In other places hand or machine excavating may be employed at the discretion of Contractor.

## ii) Types of Trench Excavation

### 1. Common and Sand Excavation.

- A When excavating in ordinary soil or sand the Contractor shall take all precautions to prevent slides caused by material placed alongside the trench or for any other reason.  
Wherever the danger of slides exists, the Contractor shall slope the trench walls, install supports, bracing, etc., and shall make all other arrangements which may be necessary to prevent slides.

### 2. Trench Excavation in Rock.

- A Trench walls excavated in rock shall be as nearly vertical as possible, and the Contractor shall consolidate the walls wherever they have been loosened by blasting or for other reasons, or shall remove the loosened material.

### 3. Trench Excavation in water.

- A Where rivers carrying water during construction are to be crossed, the Contractor will have to excavate the pipe trench under water. The depth and width of the trench at such places shall be as specified above. The exact trench profile at river crossing will be shown on drawings or determined by the Engineer on the site. The Contractor shall take all necessary measures to maintain the trench in its proper shape and to prevent it from being filled with eroded earth or mud until the pipe has been laid.

## iii) Mechanical Excavation

- A. The use of mechanical equipment must be jointed with the approval of the Engineer. The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts or other existing property, utilities or structures above or below ground. In all such locations hand

excavation shall be used. The Contractor will be held responsible for making good at his own cost all additional damage to road surfaces and private lands caused by the use of mechanical excavators.

- B. Mechanical equipment if used for trench excavation shall be of type approved by the Engineer. Equipment shall be so operated that the rough trench excavation bottom can be controlled, that uniform trench widths and vertical sides are obtained at least from an elevation 200mm above the top of the installed pipe when accurately laid to specified alignment will be centered in the trench with adequate clearance between the pipe and sides of the trench.

#### **iv) Alignment and Minimum Cover**

- A The alignment of each pipeline shall be fixed and determined from offset stakes. Horizontal alignment of pipes and the maximum joint deflection used in connection therewith, shall be in conformity with requirements of the section covering installation of pipe.
- B Pipe grades or elevations are not definitely fixed by the Contract Drawings, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe of 900mm for diameters 150mm and above, 700mm for diameters less than 150mm or as mentioned in the bill of quantities . Greater pipe cover depths may be necessary at certain locations, the locations and depths will be determined by the Engineer, and will be followed by the Contractor. Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finish ground or pavement surface elevation except where future surface elevations are indicated on the Drawings. Where there is no adequate minimum cover, concrete encasement will be used as hereinafter and as shown on the Drawings and as directed by the Engineer.

#### **v) Excavation in Confined Areas .**

- A In confined areas, where the passage of excavating equipment is impossible, or where the Engineer deems to use of such equipment impracticable or undesirable for any reason whatsoever, trench excavation shall be done by hand. All requirements specified above for common or sand excavation shall also apply to trench excavation by hand.

#### **vi) Padding of Trench Bottom .**

- A Wherever the trench bottom is in rock or where the Engineer will decide that the trench bottom is unsuited for laying of pipe on it, the trench will be excavated to an additional depth, and the Contractor shall pad the trench bottom with a layer 100 mm thick of selected excavated material not containing stones larger than 30 mm measured in any direction provided that the quantity of stones smaller than 30 mm is not more than 20% by volume.
- B The surface of the padding shall be finished to grade as specified above so as to provide an even and solid support for the pipes to be laid.

## **2.7 Excavation for Concrete Valve Chambers**

- A Excavation for the concrete valve chambers shall be carried out to the dimensions, lines and grades shown on the Drawings or required by the Engineer.
- B Wherever the depth of the excavation or the nature of the soil makes it necessary to avoid caving in, the Contractor shall excavate the walls to a slope or brace and support the excavation.

- C Should nevertheless earth slides occur, the Contractor shall remove the material resulting therefrom, clean the excavation of all stones, clods and other loose material and shall provide a clean excavation surface in which concrete can be cast according to the required dimensions and grades.
- D Should it appear that the bottom of the excavation does not provide a solid base for the casting of the concrete floor, the Contractor will be required to consolidate the bottom using hand tampers and increasing the moisture content, if required, until the required density is obtained, a/o placing concrete class (B150) as blinding, all as directed by the Engineer.
- E Any over-excavation at the bottom of the structure shall be restored to the proper grade by filling the over-excavation class (B150) concrete or shall be filled with the concrete of which the structure is cast. In the case of over-excavation in the walls, whether caused by careless work or by the necessity to prevent slides by excavating to a slope or for any other reason, the Contractor shall remove all loose material from the excavation, cast the walls of the structure to the dimensions shown on the Drawings and fill the spaces between the structures and the sides of the excavation with compacted backfill in layers of 100mm thickness. The material of the backfill shall be moistened if necessary and compacted to the level of the adjacent natural soil.

## **2.8 Excavation for Concrete Blocks**

- A Excavation for concrete anchoring blocks shall be performed according to the shapes and dimensions shown on the drawings. The bottom and sides of the excavation shall be smooth, even, and solid so that concrete can be cast against them. Where necessary, such surfaces shall be moistened and consolidated to make them suitable for the casting of concrete against them. Any over excavation on the bottom or sides shall be cleaned, smoothened out, and filled with concrete cast integrally with block.
- B After the block has been cast, and subject to the Engineer's approval, it shall be covered where necessary with excavated material up to the natural ground surface. The rest of the excavated material shall be removed and dump as specified above for the material excavated for valve chambers.

## **2.9 Backfilling of Trenches**

### **i) General**

- A Every section of the pipeline shall be covered as soon as possible after being lowered into trench, but no section of the line shall be covered without express approval of the Engineer. Each section shall be backfilled after the pipe has been placed in its final position on the trench bottom and after all weld joints and bends have been coated and all defects in the pipe coating repaired.
- B Backfilling shall be done carefully to prevent displacement of the pipe or injury to the pipes and their coating. The backfill material shall completely fill the entire space between the pipe and the trench surfaces, without leaving any voids.
- C Care shall be taken that the backfill material does not contain any electrodes, scrap iron, fragments of timber or shrubs, roots, broken skids, tyres, ashes, refuse, oil or soil soaked with oil. Stones removed during trench excavation may be used in the second stage of backfilling as specified below.
- D On hillsides or sloping ground, furrows or terraces shall be provided across the pipeline trench to direct the flow of rainwater into the natural drain courses and away from the pipeline trench.
- E Where the pipeline crosses natural drainage channels, an opening in the backfill shall be made to avoid interference with normal drainage of the surrounding land.

- F Backfilling shall be done so as not to spoil the road or disrupt its continuity.

## ii) Backfilling of Trenches in Cross-Country Areas

Where the pipes are laid cross-country, the backfilling of trenches shall be done as follows:

- A **Soft Backfill** (surrounding the pipe) shall consist of sand from any approved source or fine aggregates. This material shall be placed 150 mm below the invert level up to 200 mm over the crown of the pipe and for the full width of the trench, or to the depths specified in the Bill of Quantities.
- B **Final Backfill** for the remainder of the trench shall be by using well graded approved backfill material. (as specified herein after in paragraphs 2.11( i , ii ))
- C The trench shall be filled to the level of the natural adjacent ground level in layers not exceeding 300 mm, wetted and compacted by rolling, tamping to 90 percent of maximum dry density. If rolling is employed, it shall be by use of a suitable roller or tractor, being careful to compact the fill throughout the full width of the trench.
- D Other layer of the same material shall be mounded 150 mm above the existing grade or as directed by the Engineer.

## iii) Backfilling of Trenches in or Adjacent to Streets

Where the pipes are laid in or adjacent to streets, the backfilling of trenches shall be done as follows :

- A **Soft Backfill** shall be done as specified above in paragraph 2.9(ii-A)
- B **Final Backfill** for the remainder of the trench shall be by using well graded approved backfill material. (as specified herein after in paragraphs 2.11( i , ii ))
- C The selected backfill shall be up evenly on all sides, in layers not exceeding 250 mm measured before compaction, thoroughly wetted and compacted by rolling, tamping, or vibrating with mechanical compacting suitable equipment or hand tamping, to 95 percent of maximum dry density. Where these methods are not practicable, compaction shall be done by using of pneumatic ramming with tools weighing at least 10 Kg. The materials in this case being spread and compacted in layers not more than 150 mm in thickness. If necessary, sprinkling shall be employed in conjunction with ramming.
- D The top 250mm sub-base for pavement replacement, shall consist of one layer of approved basecourse material, wetted and compacted to 95 percent of maximum dry density.
- E Should the contractor wish to use the material excavated from the trench as sub-base for pavement replacement, the contractor shall at his own expense have samples of the material tested by an independent and certified laboratory at intervals not to exceed 150 m, in order to establish its compliance with the specifications. Only material which has been tested by the contractor and approved by the engineer shall be allowed to be incorporated into the work.

## iv) Backfilling of Trenches with Excessive Slopes

- A On trenches with slopes exceeding 15 percent, a 300 mm wide, stone partitions shall be built across the trench every 10 meters length.
- B These partitions shall be done constructed over the first stage of the backfill up to the natural ground level, and shall exceed the trench width with 200 mm from each side inside the ground.



### **v) Restoring Trench Surface**

- A Where the trench occurs adjacent to paved streets, in shoulders, sidewalks, or in cross-country areas, the contractor shall thoroughly consolidate the backfill and shall maintain the surface as the work progress. If settlement takes place, he shall immediately deposit additional fill to restore the level of the ground. In some areas it may be necessary to remove excess materials during the clean-up process, so that the ground may be restored to its original level and condition.
- B The surface of any driveway or any other area which is disturbed by the trench excavation and which is not a part of the paved road shall be restored by the contractor to a condition at least equal to that existing before work began.
- C Where the pipes are laid in cross-country areas, and where the danger of erosion exists, the uppermost 300 mm part of the trench may be backfilled with common backfill material containing fragments of ledge and boulders smaller than 150 mm providing that the quantity in the opinion of the engineer, is not excessive. Small stones and rocks shall be placed in thin layers alternating with earth to insure that all voids are completely filled.
- D All road surfaces shall be broomed and hose-cleaned immediately after backfilling. Dust control measures shall be employed at all times.

## **2.10 Backfilling around Structure**

### **i) General**

- A Surfaces to receive backfill shall be cleared of debris and unsatisfactory materials prior to the placement of the backfill material
- B When the top 200mm of surface to receive backfill has a density less than the required maximum dry density, break up surface, pulverize, moisten and compact such that the required degree of compaction is achieved to form a "compacted subgrade".
- C Backfill excavations as promptly as the work permits, but not until completion of inspection, testing, approval, and recording of location of underground utilities, as required.

### **ii) Backfilling - Common Fill**

- A Common Fill may be used as fill against exterior walls of structure as indicated on the drawings. Materials conforming to the requirements of common backfill shall be placed in layers having a maximum thickness of 300 mm measured before compaction, each layer of fill or backfill shall be moistened or aerated and compacted to at least 90 percent of maximum dry density, or as specified in the Bill of Quantities.
- B Backfill or fill materials shall not be placed on surfaces that contain excessive moisture, preventing specified degree of compaction.
- C Material placed in fill areas shall be deposited to the lines and grades shown on the drawings making due allowance for settlement of the material.
- D No compacting shall be done when the material is too wet either from rain or from excess application of water. At such cases, work shall be suspended until previously placed and new materials have dried sufficiently to permit proper compaction.

### **iii) Backfilling - Structural Fill**

- A Structural fill shall be placed in layers having a maximum thickness of 200 mm in open areas and 150 mm in confined areas including points where conduit and piping join structures, measured before compaction. Each layer shall be moistened or aerated and compacted to at least 95 percent of maximum dry density, or as specified in the Bill of Quantities, by methods approved by the Engineer. The limits of structural fill adjacent to structures shall extend as shown on the drawings.
- B Compaction of Structural fill in open areas shall consist of fully loaded ten-wheel trucks, a tractor dozer weighing at least 13.5 ton and operated at full speed, a heavy vibratory roller, or any method approved by the Engineer.
- C Compaction of structural fill in confined areas shall be accomplished by hand operated vibratory equipment or mechanical tampers approved by the Engineer.

## **2.11 Material Used in Backfill**

### **i) General**

- A Backfill and fill material shall be suitable excavated material, natural or processed mineral soils obtained from off-site sources, or graded crushed stones or gravel.
- B Backfill and fill material shall be free from all organic material, trash, snow, ice, frozen soil, or other objectionable material which can't be properly compacted. Soft, wet, plastic soils which may be expensive, clay soils having a natural in-place water content in excess of 30 percent, soil containing more than 5 percent (by weight) fibrous organic material, and soil having a plasticity index greater than 30 shall be considered unsuitable for use as backfill and fill material.
- C Backfill and fill material shall have a maximum of one percent expansion when testing is performed on a sample remolded to 95 percent of maximum dry density at a two percent below optimum moisture content under a 490 kg/m<sup>2</sup> surcharge.

### **ii) Common Backfill Material**

- A Common Backfill or fill material shall not contain Granite blocks, broken concrete, masonry rubble, asphalt pavement, or any material larger than 150 mm in any dimension provided that this material is not more than 25 percent of the backfill or fill material.
- B Common Fill shall have physical properties, as approved by the engineer, such that it can be readily spread and compacted.

### **iii) Selected Backfill Material**

- A Selected Backfill and Fill material shall conform to the requirements of common Backfill except that the material shall not contain any materials larger than 50 mm in its largest dimension provided that this material is not more than 20 percent of the Backfill or fill material.

### **iv) Structural Fill**

- A Structural Fill shall be gravel, sandy gravel, or gravelly sand. Material shall have a plasticity index of less than 15 and shall conform to the gradation limits shown in table 2.1 below :

Table 2.1

Sieve Size	Percent Finer By Weight
150 mm	100
No. 4	20 - 70
No. 40	5 - 35
No. 200	0 - 7

### v) Crushed Stones

- A Crushed stones shall be sound, durable stone, angular in shape, and free of foreign material, structural defects and chemical decay. Crushed stones shall be of a maximum dimension of 50 mm and in a minimum of 12 mm measured in any direction.

## 2.12 Quality Assurance

### Laboratory Testing

- A At least seven days prior to the placement of any Backfill or Fill material, the contractor shall deliver a representative sample of the proposed material weighing at least 22 Kg to an approved soils testing laboratory to perform:
- A. Grain size analyses of the samples to determine their suitability for use as Backfill or Fill material in accordance to the material requirements specified in section 2.11
  - B. The appropriate Proctor analysis to determine the maximum dry densities required for compaction testing as specified in the contract documents.
  - C. The test results and determinations of suitability shall be delivered to the engineer no later than three days prior to the placement of Backfill or Fill materials.

## 2.13 Replacement of Pavements and Structures by the Contractor

- A Unless otherwise shown on the Drawings or mentioned in the bill of quantities, the Contractor shall restore all pavements, sidewalls, sidewalks, curbs, gutters, shrubbery, fences, poles, sod, or other property and surface structures removed or disturbed as a part of the work to a condition equal to that before the work began, and shall furnish all incidental Labour and materials. No permanent pavement shall be restored unless and until, in the opinion of the Engineer, the condition of the backfill is such as to properly support the pavement and not before written approval from the Engineer to commence such works.
- B Where pipelines pass underneath asphalted roads and parallel to the axis of the road, the final 250 mm of the trench backfill shall be furnished as follows:
  1. 200 mm (after compaction) shall be done by using approved base course material, placed, wetted and compacted to not less than 95 % of the modified Proctor density.
  2. Spraying 2 kg of prime coat(MCO) per each square meter over the compacted base course, and applying a layer of asphalt mix of size 7.5, in a thickness not less than 50 mm, after compaction which should satisfy the specification of Palestinian Ministry of Public Works.

## 2.14 Measurement and Payment

- A. All Excavated material of whatever type shall be measured as “unclassified” which shall be deemed to include all materials encountered of any nature, including silts, clays, sand, gravel and granular materials and fractured, jointed and solid rock, and unsuitable material.
- B. Trench Excavation shall be measured in lin.m of each range of depth, as classified in the Bill of Quantities, and trimmed to required line, grade and cross section, including depositing excavated material along the side of trench if directed or hauling away and wasting, stockpiling or depositing on or in the vicinity of the works completed and accepted.
- C. Structural Excavation shall be measured by cubic meter of original ground elevations. Limits shall not be greater than vertical planes 500mm (working space) from the maximum dimension, on each side of the footing or other controlling portion of the structure. Where structures are to be constructed against natural ground or rock, excavation limits shall be the dimensions of the structure as shown on the Drawings. Bottom limits shall be the ordered foundation elevations. Only material excavated from its original position shall be measured for payment. No measurements shall be made of structural excavation in embankments previously constructed by the Contractor.
- D. Structural Excavation shall be paid for material excavated for chambers, valves or any needed fittings, hauled away and disposed of as directed, or stockpiled on or in the vicinity of the works, and the excavated areas backfilled, completed and accepted.
- E. Sub excavation of Unsuitable Material shall be measured by lin.m for trench and cu.m for structures of unsuitable material subexcavated as ordered, hauled away and disposed of as directed, and the excavated areas backfilled, completed and accepted.
- F. Unauthorized overdepth and overwidth excavation and the concrete backfill required in such cases, shall not be measured for direct payment, but shall be considered as Subsidiary Works the cost of which will be deemed to be included in the Contract Prices for Pay items.
- G. Temporary cofferdams, temporary shoring and cribbing, bailing, drainages pumping, sheeting, and all other Temporary Works shall not be measured for direct payment, but shall be considered as Subsidiary Works the costs of which will be deemed to be included in the Contract Prices for Pay Items.
- H. Backfilling of trenches mentioned in item 2 above shall be measured in lin.m. Backfilling shall include preparation of subgrade, furnishing required suitable backfilling materials, placing and compaction of backfilling material as specified and shall be made in accordance with methods specified in two stages :
- I. Soft Backfilling from the bottom of the trench to at least 200 mm above the crown of the pipe, with sand or fine aggregate fill as specified
- J. Final Backfilling for the remainder of the trench above the zone around the pipe with selected fill material as specified.
- K. Reinstatement of roads, side walks, and paved surface shall be measured in lin.m. The work will include removal, restoration and maintenance of surfaces and property, preparation of road foundation and replacement of hard core, asphalted layer and structures.

## SECTION 3 : CONCRETE AND REINFORCED CONCRETE

### 3.1 General

- A. This section consists of furnishing all plant, equipment, appliances and materials and in performing all operations necessary in the construction in accordance with the Specifications, Drawings and Engineer's instructions and subject to the terms of the Conditions of Contract.
- B. Unless approved by the Engineer to mix the concrete on Site for small quantities, all types of concrete will abide with the requirements of Palestinian Standards (PS 40) and will be furnished to the site as ready mixed concrete supplied from an approved ready mixed plant by the Palestinian Standards Institute. Contractor must obtain Engineer's approval of the concrete plant prior to the delivery of concrete from same.
- C. All concrete works except for foundations shall be executed as exposed fair faced concrete and will abide with all requirements for same.
- D. All concrete casting will fully abide with "good" control conditions requirements and approved by the Engineer.

### 3.2 Material

#### i) Cement

- A. The cement shall be sulphate-resisting cement of local manufacturer meeting requirements similar to those of ASTM Specifications C150, latest edition, for type V. Cement shall be fresh and suitable for use as approved by the Engineer.

#### ii) Aggregate

##### Fine Aggregate

- A. Sand for concrete, mortar and grout shall be furnished by the Contractor from any approved source and shall be natural sand or a mixture of natural sand and fine crushed stone. The sand shall meet the requirements of Palestine Standards PS 48-1997, with the additional requirement that the specific gravity of the sand shall not be less than 2.50.
- B. Unless otherwise specified the sand shall be graded as shown in table 3.1 below:

**Table 3.1**

Sieve Size mm	Percentage Passing by Weight
4.75	100
2.36	80-100
1.18	30-75
0.60	25-60
0.30	10-30
0.15	0-10

##### Coarse Aggregate

- A. Coarse Aggregate for concrete shall be furnished by the Contractor from an approved source and shall consist of hard dense durable uncoated rock fragments and shall meet the requirements of Palestine Standards No. PS 48-1997, with the following limitations.

- B. The Los Angeles Abrasion test should not exceed 32% according to PS 48 for grade B and 28% for grade A . Water absorption should not be more than 2.5 % more than the absorption of Bazelt aggregate retained an 9.5 mm sieve i.e. the total absorption should not exceed 3.5 % and the specific gravity shall not be less than 2.50. The grading of coarse aggregate shall be as shown in table 3.2 below:

**Table 3.2**

<b>Nominal Sizes 19.0 mm</b>	
<b>Sieve Size mm</b>	<b>Percentage Passing by Weight</b>
25.0	100
19.0	85-100
14.0	0-20
9.5	0-5
<b>Nominal Size 25.0 mm</b>	
<b>Sieve Size mm</b>	<b>Percentage Passing by Weight</b>
37.5	100
25.0	85-100
19.0	0-20
14.0	0-5

- C. The size of coarse aggregate used in any part of work shall be such that it does not contain any particles larger than 1/3 of the thickness of the thinnest concrete member or ? of the smallest distance between reinforcement bars whichever is smaller

### Combined Aggregate

- A. The grading of combined aggregate shall be approximately as shown in table 3.3 below:

**Table 3.3**

<b>Sieve Size mm</b>	<b>Percentage Passing by Weight</b>		
	<b>Grading No. 1</b>	<b>Grading No. 2</b>	<b>Grading No. 3</b>
63	95-100	--	--
50	80-100	100	--
37.5	65-85	90-100	100
25	50-75	50-85	90-100
19	45-65	45-75	70-100
9.5	38-55	38-55	50-75
4.75	30-45	30-45	35-60
2.36	23-35	23-35	27-15
1.18	17-27	17-27	20-35

<b>Sieve Size mm</b>	<b>Percentage Passing by Weight</b>		
	<b>Grading No. 1</b>	<b>Grading No. 2</b>	<b>Grading No. 3</b>
0.3	4-9	4-9	5-15
0.15	1-7	1-7	1-5
0.075	0-5	0-5	0-5

**iii) Water**

- A Water used in concrete either for mixing or curing shall be fresh potable water derived from an approved source of supply and shall be free from silt, oil, organic matter, acid, alkali-slare and other deteriouise substances. The temperature of the water shall not be less than 10? C. the water shall meet the requirement of Palestinian Standards No. PS 41-1997.

**iv) Reinforcing Steel**

- A The steel bars to be used are of plain steel complying with PS 50 and deformed ribbed steel bars complying with PS 52. Before bending the steel is to be straightened to the Engineer's satisfaction and cleaned of all rust loose mill scale, oil or any other dirt.
- B Spacers shall be made of precast concrete cubes which shall match the concrete into which they are cast in every way ( strength proportion, color).
- C Jointing of reinforcement bars shall be done with overlap no less than 50 times the diameter of the respective bar.

**v) Additives**

- A Where required or approved by the Engineer, the Contractor shall use additives such as plasticisers or retarders in the concrete. Proportioning and mixing of additives thereof to be used in the concrete shall be in accordance with manufacturer's recommendations and subject to the Engineer's approval. Additives shall be added to the batch in solution in a proportion of the mixing water according to the manufacturer instructions. This solution shall be batched in such a manner as will ensure uniform distribution of the additive throughout the batch during the specified mixing period.
- B Additives shall be suitable for use in contact with potable water after 30 days of concrete curing.
- C All additives shall satisfy the requirements of PS 125 accompanied with a certificate of compliance from approved laboratory.
- D The additives used shall be furnished by the Contractor, and the cost of the materials and all costs incidental to their use shall be included in the unit prices bid in the Bill of Quantities for concrete in which the materials are used.

**3.3 Types and Strength of Concrete .**

- A Types and Strength of Concrete to be used in the works are as shown in table 3.4 below:

**Table 3.4**

Type	Cube Strength after 28 days [MPa]	Minimum Quantity of cement kg per m <sup>3</sup> of concrete	Maximum Permissible Water/cement Ratio
B 150	18	220	0.60
B 200	23	260	0.55

- B Concrete type B200 shall be used as watertight for manholes chambers, thrust blocks, encasements, benching or where specifically directed by the Engineer. Concrete type B150 for fill below pipes in trenches, blinding, street crossing or as indicated on Drawings.
- C The Contractor shall be free to fix the proportions of the mix provided that it could be demonstrated that the mixes used have the lowest possible water content consistent with proper grading and good workability for the sake of minimum drying shrinkage, and on condition that the Contractor can prove by advance testing carried out in approved laboratory, that they are suitable, comply with all the requirements of the specifications, and that they can be transported, placed and compacted by the methods and equipment used on site.

### **3.4 Forms and Shuttering**

- A. All forms for casting of concrete shall be made of steel, plywood, mazonite or similar material providing a completely smooth surface of the face coming in contact with the concrete. Only new, strong and smooth timber shall be used for shuttering and scaffolding.
- B. The Contractor shall bear the sole responsibility for the safety and stability of the forms, scaffolds etc., and in the case of collapse, excessive deflections, buckling and /or any other changes in shape, the damage shall be repaired by the Contractor at his expense.
- C. Form ties shall be internal where possible. The tying of forms in the walls shall be made with special accessories fitted with cones or accessories of approved type by the Engineer so as to ascertain complete sealing after stripping of forms, and avoid any seepage of water at the ties. After the tie fittings have been removed, the holes shall be filled with epoxy on the inside and cement grout of the approved type by the Engineer on the external face.
- D. Forms shall be stripped only with the Engineer's approval. The minimum period from completion of casting to commencement of stripping will be as follows :

Walls	- 48 hours
Roof	- 14 to 21 days

### **3.5 Mixing and Placing of Concrete**

- A. Contractor will have to submit for Engineer's approval a scheme of the proposed forms and shuttering as well as a detailed schedule for casting proceedings.
- B. Contractor must inform the Engineer of any scheduled casting at least 48 hours prior to the casting and must obtain Engineer's approval to the proposed schedule.
- C. When mixing on site is approved by the Engineer, concrete shall be machine mixed with approved machines.
- D. The location of the mixing plants shall be agreed on with the Engineer and the Contractor must submit to the Engineer for approval before erection of any mixing plant his proposed arrangements for the storing of aggregates, batching and mixing of the concrete.
- E. The placing of concrete in any element is to be carried out continuously without pause, in a manner which will not produce construction joints or cold joints due to partial drying of compacted concrete .
- F. The concrete transported by transit mixer or agitators, the time elapsing from the time water is added to the mix until the concrete is deposited in place shall not be greater than the time taken for 300 revolutions of the transit mixer or agitator or 20 minutes, whichever is the least.



- G. Driver of delivery trucks shall be provided with trip tickets, which shall be signed by a responsible member of the central plant staff, for submission to the Engineer. The ticket shall contain name and address of the central plant, serial number of the ticket and date, truck number, class and/or strength of concrete, cement content of the mix, loading time, slump and any other type of relevant information. The Engineer may send his representative to the central plant to check the batching and mixing, verify loading time and take a copy of the trip ticket.
- H. The placing of fresh concrete will be gently placed in position and will not be allowed if the free fall is more than 2.0m. Concrete shall not be placed in such a manner that it displaces reinforcing bars, ties, etc. The fresh concrete is to be placed in its final destination in accordance with the above mixing and batching procedures. Any concrete that has become so stiff that proper placing cannot be assured, shall be wasted.
- I. Concrete shall be consolidated to a maximum practicable density, by means of vibration, so that it is free from pockets of coarse aggregate and entrapped air, and closes snugly against all surfaces of forms, reinforcing steel bars and embedded materials. The slump for concrete thus consolidated must be fairly high and the cement quantity increased accordingly to achieve specified strength.

### 3.6 Joints

- A. Working joints in the concrete will be permitted only in places marked on the Drawings or as approved by the Engineer.
- B. Working joints will not be measured for payment and Contractor will incorporate their cost in the unit prices for concrete works.
- C. Joints with P.V.C water stops will be constructed as marked on the Drawings or requested by the Engineer.
- D. The water stops will be of P.V.C strips 240 x 4 mm. supplied by an approved manufacturer and approved by the Engineer. Contractor must furnish samples of water stop to be used along with the manufacturer's certificate specifying the characteristics and quality of the material.
- E. Engineer's approval of the sample does not release the Contractor from any responsibility to the quality of the material and the proper execution of the joint.
- F. Water stops will be furnished to the site as complete units having the shape and dimensions as indicated on the Drawings.
- G. The edges of the water stop will be joined by welding since no overlap will be permitted.
- H. The water stop will be inserted accurately in the elements of the structure cast first and will be properly protected from any damage, dirt or distortion of its shape and position. Prior to casting the adjoining part of the concrete element, face of the joint will be properly cleaned and a 3 mm. hot asphalt coat will be applied on the whole of the joint area. Sealing of joints shall be completed by filling the groove with an elastoseal pack as marked on the Drawings.

### 3.7 Curing

#### i) Materials

- A. Hessian or Burlap : They shall be clean and free from harmful materials. Their unit weight shall be not less than 230g/m<sup>2</sup>.
- B. Impermeable membrane : The following impermeable membranes may, with the Engineer's approval, be used.
  - a. Clear polyethylene film with no holes, tears, scratches and contamination of any type.

- b. Hessian coated with white polyethylene of density not less than 300g/sq.m. The coating may be on one side only but shall be not less than 0.1mm thick and shall not peel during and after use.
- C. Curing Compounds : These shall conform to AASHTO M148 (ASTM-C309).
- D. Sand : It shall be natural sand free of silt and clay and contaminants which can be harmful to the concrete.
- A. Water : It shall satisfy the requirements of Section 3.2 of the Specification.

## **ii) Method of Curing**

- A. General : The method of curing to be used shall be approved by the Engineer. It shall not cause any undesirable blemishes such as surface discolorations and surface roughness. Curing compounds shall not be used on construction joints and surfaces that are to receive waterproofing, paint or membranes.
- B. Ponding : Curing by ponding may be used for horizontal surfaces such as bases, pile caps and slabs. Large areas of horizontal surfaces shall be separated into ponds not exceeding 5 sq.m. The ponds shall first be filled between 12 to 24 hours after pour, unless otherwise authorised by the Engineer, and shall be replenished from time to time so as to maintain the ponding for the specified curing period. The concrete temperature and the temperature of the curing water shall be not greater than 20°C.
- C. Sprinkling : Unless otherwise approved by Engineer, curing by spraying shall commence between 12 to 24 hours after the concrete pour. The concrete shall be maintained damp at all times during the curing period by periodic light sprays.
- D. Wet Hessian / Burlap : Members to be cured by wet hessian or wet burlap shall be completely wrapped with the material which shall be kept moist at all times during the curing period by regular spraying. Unless otherwise approved by the Engineer, the overlap under normal conditions shall be not less than one-quarter the width of the hessian or burlap and not less than one-half the width in windy and/or rainy conditions. Before members are wrapped for curing, they shall first be evenly moistened. Unless approved by the Engineer, burlaps shall be supplied only in rolls and burlap bags shall not be used. Secondhand hessian and burlap, if approved for use, shall be clean without holes and contamination of any kind that can affect the concrete.
- E. Waterproof Sheets : Waterproof sheets used for curing shall, unless directed by the Engineer, be spread immediately after the pour. The sheet shall, unless approved by the Engineer, be clear of the concrete surface but be arranged in such a manner as to prevent the movement air over the concrete surface. Waterproof sheets shall not be used when the air temperature is 25°C or higher.
- F. Curing Compounds : Curing compounds shall be applied in two applications at a coverage rate of not less than 1 ltr/ 7.4 sq.m. per application or as recommended by manufacturer.
- G. The first coat shall be applied immediately after the removal of the forms and the acceptance of the concrete finish and after the disappearance of free water on unformed surfaces. If the concrete is dry or becomes dry, it shall be thoroughly wetted with water and curing compound applied just as the surface film of water disappears. The second application shall be applied after the first application has set. During curing operations, any unsprayed surfaces shall be kept wet with water. The curing membrane will not be allowed on areas against which further concrete is to be placed.
- H. Hand operated spray equipment shall be capable of supplying a constant and uniform pressure to provide uniform and adequate distribution of the curing membrane at the rates required. The curing compound shall be thoroughly mixed at all times during usage.

- I. The curing membrane shall be protected against damage for the entire specified curing period. Any coating damaged or otherwise disturbed shall be given an additional coating. Should the curing membrane be continuously subjected to injury, the Engineer may require wet burlap, polyethylene sheeting, or other approved material to be applied at once.
- J. No traffic of any kind will be permitted on the curing membrane until the curing period is completed, unless the Engineer permits the placement of concrete in adjacent sections, in which case the damaged areas shall be immediately repaired as directed.
- K. Steam Curing  
 Low Pressure Steam Curing : This shall be in accordance with recommendations of ACI 517.  
 High Pressure Steam Curing : This shall be in accordance with the recommendations of ACI 516.

### iii) Curing Time

- A. The minimum curing time shall be the number of days given in the Table below unless the average surface temperature of the concrete during the required number of days falls below 10 °C, in which case the period of curing shall be extended until the maturity of the concrete reaches the value given in the Table.

#### NORMAL CURING PERIODS

Minimum periods of protection for different types of cement						
Conditions under which concrete is maturing	Number of days (where the average surface temperature of the concrete exceeds 10°C during the whole period)			Equivalent maturity (degree hours) calculated as the age of the concrete in hours multiplied by the number of degrees Celsius by which the average surface temperature of the concrete exceeds minus 10°C.		
	Other*	SRPC	OPC or RHPC	Other*	SRPC	OPC or PHPC
1. Hot weather or drying winds	7	4	3	3500	200	1500
2. Conditions not covered by (1)	4	3	2	2000	150	1000

NOTE  
 KEY. Other\* includes all permitted cements except OPC, PHPC and SRPC.  
 OPC = Ordinary Portland Cement  
 RHPC = Rapid-hardening Portland Cement.  
 SRPC = Sulfate Resisting Portland Cement.

- B. The minimum curing time given in the Table above shall be compared with the time required for cubes, cured under identical conditions to those which the concrete is subjected to, attain 70% of the characteristic strength. The greater shall be taken as the minimum curing time.

### 3.8 Concrete Repairs and Finish

- A. All repair works that might be required on sections of the cast concrete shall be performed by the Contractor not later than 24 hours after removing of forms.

- B. If not otherwise instructed, Contractor will cut all projecting tie wires to a depth of 15 mm, into concrete face and fill the recess with fresh concrete. Concrete projection caused by roughness of forms will be chiseled away or otherwise removed by a polishing carborundum stone. Gravel pockets, holes or faulty spots shall be chiseled out until clean and healthy concrete is exposed. All recesses shall be filled up with fresh concrete of approved cement grout and properly repaired. The repaired section will merge with the concrete of the structure and smoothened level with its surface.
- C. All repair works will be performed only after damaged part has been checked by the Engineer.
- D. All finish works shall be performed by the Contractor at his expense and he would not be entitled to any compensation for the same.

### **3.9 Construction of Manholes**

#### **i) General**

- A. The Contractor shall construct manholes in reinforced cast-in-place concrete or in precast concrete rings to the levels, dimensions and shapes shown on the Drawings, or as directed by the Engineer.
- B. All manholes shall be constructed with incoming and outgoing pipes neatly and truly concreted in, complete with benching, cast iron steps and manhole cover and frame as here specified and shown on the Typical Drawings.

#### **ii) Manholes**

- A. The Contractor shall construct a well compacted blinding layer of plain concrete Type B 150 to the required levels after the Engineer has inspected and approved bottoms of excavations. The surface of the blinding layer shall be regular and smooth.
- B. The Contractor shall set tops of manhole frames and covers to the elevations as indicated on Drawings, unless otherwise directed.
- C. All items built into walls of manholes and structures such as pipe ends shall be adequately sealed to obtain watertight construction to the satisfaction of the Engineer. Steps shall be installed in a staggered pattern to the extent indicated at not more than 300 mm centers and shall be well grouted.
- D. Changes in direction of gravity sewers shall be made through the use of a manhole.
- E. House connections shall be made to manholes using a piece of pipe called socket.
- F. Drilling shall be used when connecting pipes into manholes.
- G. Covers and frames shall be well centered and anchored all around to the approval of the Engineer.
- H. After the installation of the cast iron frames, the Contractor shall provide plain concrete Type B 150 in surrounds as indicated on Drawings. Surrounds shall be well haunched all round and trowelled smooth.
- I. Drop fittings : Drop manholes shall have drop pipes and fittings installed such that the crown of the incoming drop pipes shall be at the same elevation as that of the outgoing pipe. Drop pipes shall be of the same diameter as the incoming pipes. The drop pipes and fittings shall be encased in plain concrete Type B 200 as indicated on the Typical Drawings.
- J. Benching to manholes shall be constructed in plain concrete, Type B 200, well formed and streamlined and smooth trowelled in channels, bends and junctions.

- K. All manholes steps, covers and it's frames shall be well cleaned and painted with black paint of bituminous base after complete installation and to the approval of the Engineer.
- L. All manholes shall be properly ventilated as shown in the Typical Drawings.

### iii) Cleaning

- A. All manholes shall be cleaned of any accumulation of silt, mortar, debris or other foreign matter and shall be free of any such accumulation at the time of final inspection.

### iv) Reinstatement of Staircases

- A. Staircases shall be reinstated as shown on the Typical Drawings and the type of reinstatement shall be decided by the Engineer according to the equal to that before the work began.

## 3.10 Metal Components Embedded in Concrete

- A. All metal components that have to be fixed in the concrete such as pipe sections, steel frames and covers, hooks, ladders etc., shall be tightly placed in their right position within the shuttering prior to casting of concrete. All faces of metal parts that will be embedded in the concrete shall be thoroughly cleaned removing all dirt like, oil, paint, scale etc., in order to secure thorough adhesion between concrete and metal. Where pipes have to be anchored in the concrete, anchoring rings shall be welded to the pipe. In case a free passage of the pipe is required through the concrete, pipe should be wrapped with a bitumen saturated felt or a similar elastic sealing material.

## 3.11 Concrete Tests

- A. Concrete tests shall be carried out in accordance with PS 55. Preliminary tests shall be made by the Contractor to determine suitable mixes. Routine tests shall be taken for cube strength according to PS 55-part 1- 1997 as shown in table 3.5 below:

**Table 3.5**  
**Minimum No. of concrete samples.**

Quantity of Concrete [m <sup>3</sup> ]	No. of Samples
Up to 40	3
from 40 up to 60	4
60 up to 80	5

Quantity of Concrete [m <sup>3</sup> ]	No. of Samples
80 up to 100	6
100 up to 130	7
130 up to 160	8
160 up to 200	9
for each additional 50 m <sup>3</sup> above 200	additional sample

Note : every sample consists of two cubes one to be tested at 7 days and the other at 28 days.

- B If the mean value of strength does not comply with the requirement of PS 45 the particular structural element must be core tested according to PS 55 part 6-1997, if the cores don't comply with the requirement, Engineer shall have the right to require strengthening or replacement of that element which fail to develop the required strength. All remedies associated costs shall be at the expense of the Contractor.
- C All costs in connection with the tests shall be at the Contractor's own expense.

### 3.12 Precast Elements

- A. Precast elements shall be either of concrete or mortar as shown on the Drawings and as specified hereinafter

#### i) Materials

##### a) Precast Concrete Elements

Precast concrete elements shall be of plain or reinforced concrete dimensions, thickness and reinforcement rods and bars shown on the Drawings and stated in the Bill of Quantities.

##### b) Precast Mortar Elements

Moist tamped mortar precast elements shall be of a mixture of ordinary or tinted cement and sand (fine aggregate) approximately in the proportions of one part cement to two and one-half parts of sand. The sand shall be specially selected for colour and grading. The sand shall be screened through 3mm square meshes and all oversize particles shall be discarded. Only sufficient water shall be used in mixing to permit the immediate removal of the member from the mould. The pattern, dimensions and thickness shall be as shown on the Drawings and/or as directed in writing by the Engineer.

##### c) Mortar

Mortar for joining the precast elements shall be composed of one part of portland cement and three parts of clean sand unless otherwise specified. The cement and sand shall conform to the requirements portland cement and aggregate for mortar specified herebefore.

#### ii) Fabrication

- A. Precast concrete or mortar elements shall be cast in Mortar tight metal lined timber moulds and shall be mechanically vibrated when cast. The Precast elements shall be removed from the moulds as soon as practicable and shall be kept damp for a period of at least 10 days. Any elements that show checking or soft corners or surfaces shall be rejected. The method of storage and handling shall be such as to preserve true and even edges and corners, any precast element which becomes chipped, marred or cracked before or during the process of placing shall be rejected, sampling of precast elements shall be submitted to the Engineer for approval, prior to fabrication, at the Contractor's own expense.

#### iii) Workmanship

- A. All precast concrete or mortar elements shall be well cleaned and thoroughly wetted with clean water before placing in their positions shown on the Drawings. The precast elements shall be bedded and jointed in cement and sand mortar (1:3) mix and the joints raked out on both faces to receive plaster or pointing as indicated on the Drawings and/or stated in the Bill of Quantities to the satisfaction of the Engineer.

### 3.13 Measurement and Payment

- A. All concrete structures shall be measured by volume in cubic meters of each type of concrete according to dimensions marked on the Drawings or as specified by the Engineer. Anchor or Thrust Blocks shall be measured for payment by number of units.
- B. Ready-made manholes shall be measured for payment by number of units.

- C. All recesses, openings or any other space not actually filled with concrete shall be deducted in calculating the volume for payment. Any extra concrete which was cast due to the Contractor's negligence and is not marked specifically on the drawings shall not be measured for payment.
- D. Unit price quoted by Contractor shall include all works required to obtain designated concrete quality as well as supply of cement admixtures, and all aggregates, installing of forms and shutters and dismantling same, casting, vibrating, and compacting of concrete forming curved shapes as well as grooves or sleeves for pipes as may be required. Prices will include also taking samples, performing any laboratory tests that may be required by the Engineer and providing certificates of test results.
- E. Reinforcing steel shall be measured for payment by weight as per Drawings or Engineer's instructions. No overlaps, neither any odds or leftovers shall be counted as part of the total approved weight.
- F. Unit price for reinforcing steel shall include : supply, cleaning, bending, cutting, shaping, placing and tying of steel bars as well as overlaps, chairs and spacers.
- G. No payment will be due for working joints. Joints with water stops will be measured for payment in meter length of complete joint. Price shall include: supply of P.V.C water stop, placing, tying and jointing of water stop, applying of asphalt coat on joints face and protecting of exposed part of water stop.

## SECTION 4 : PIPELAYING

### 4.1 *Handling and Transporting of Pipes*

#### **i) General**

- A. The Contractor's arrangements for handling, lifting, transporting and stacking pipes, valves and specials, shall ensure that these articles are brought to their final place in the works undamaged and in good order.
- B. All damage to the pipes or their coating while in the Contractor's charge shall be repaired as required and directed by the Engineer, and all expenses in connection with such repairs shall be borne by the Contractor. In the event of any pipe being damaged to such an extent as to make the repair thereof, in the Engineer's opinion, impossible or uneconomical the Employer will provide a new pipe in place of the damaged one, and the Contractor shall pay the cost thereof to the Employer.
- C. When loading and unloading, handling, transporting, and moving and placing the pipes alongside and in the trench, care shall be taken to preserve the undamaged condition and roundness of the pipes, particularly at the ends. Special care shall be taken to keep the pipe coating intact.
- D. Pipes shall not be stacked on the vehicles to such a height as may cause flattening of the lowermost pipes or damage to the coating. The height of the load for the various pipe diameters shall be as recommended by the Manufacturer and approved by the Engineer. Pipe specials shall be supported by sandbags or other padding and lashed down as described above so that they are not damaged during transport.
- E. The trucks and cars used for the transporting of the pipes shall be adequately equipped to prevent displacement of pipes and/or damage to pipes or coating. Pipes shall be well secured to the vehicles to ensure stability of the load, and all parts of trucks and cars as well as cables coming into contact with coated pipes shall be well padded.
- F. Unloading of pipes from trucks or cars shall be done by means of cranes or other suitable equipment ensuring slow and careful lowering of each pipe length. Pipes shall not be gripped by hooks or other equipment liable to injure or distort pipe ends.
- G. The Contractor shall provide cranes for lifting and lowering pipes at the site of work and at the storage area and wherever pipes are being handled.
- H. Pipes must not be dropped on the ground or on other pipes. When lifting or lowering pipes by means of a crane, each pipe shall be kept under full control when suspended to prevent its colliding with equipment, rocks, trees or any other objects that may injure the pipe or its coating.
- I. Pipes shall not be moved by dragging them on the ground, but shall be lifted by crane or other means and placed carefully at their new locations. In rocky country, pipes shall be deposited with their bare ends on wooden skids at least 100 mm wide.
- J. Each pipe placed on the ground shall be prevented from rolling. Walking on coated pipes in the field shall not be permitted. Pipes shall also be protected from contact with metal tools or heavy objects that may injure the coating.
- K. No steel cables or ropes likely to injure the coating shall be used for handling the pipes, but only belts at least 250 mm wide or such special tackle as will not damage the coating.



## **ii) Ductile Iron Pipes**

- A. Considering all above mentioned general instructions, for ductile iron pipes, slings of canvas, rubber belting or other non-abrasive material, or special fittings shaped to fit the pipe ends and approved by the Engineer shall be used for lifting and lowering pipes and specials. Pipes shall not be lifted by hooks nor shall they be dropped or dragged.
- B. Ductile iron pipes being transported, shall be supported on timbers, sand bags or padding arranged so the pipes do not rest on their sockets and adjacent pipes do not touch.

## **iii) Concrete Pipes**

- A. Considering all above mentioned general instructions, concrete pipes and fittings shall not be dispatched from the factory before 28 days have elapsed after manufacturing.
- B. All pipes, and fittings shall be Sulphide resistant, and be carefully inspected and examined for cracks and other defects while suspended above the trench immediately before installation in final position.
- C. Material found to be defective or damaged shall be rejected and removed from the Work. Spigot ends shall be examined with particular care as this part is the most vulnerable to damage from handling. Any damage to exterior protective coatings shall be repaired before the pipe is laid in the trench. In case of damage to the interior protective coating or lining, the said pipe or fitting shall be laid aside for inspection by the Engineer, who will prescribe corrective repairs or rejection. Where a portion of a length of pipe is damaged, the damaged part shall be cut off in an approved manner and discarded and the remaining sound portion may be used. Any materials which fail or become damaged will be deemed to have been caused by the Contractor's negligence in handling and must be replaced with new or repaired as the Engineer decides without cost to the Employer.

## **iv) Polyvinyl Chlorine (PVC) and Polyethylene (PE) Pipes**

- A. Considering all above mentioned general instructions, PVC and PE items deteriorate in sunlight and are slightly brittle, especially at lower temperatures, so care shall be taken in loading, transporting and unloading items to prevent injury to the items. All items shall be examined before installation and no piece shall be installed which is found to be defective. Handling and installation of pipe and fittings shall be in accordance with the manufacturer's instructions, referenced standards and as specified herein.
- B. Any pipe or fitting showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.
- C. In handling the items, use special devices and methods as required to achieve the results specified herein. No uncushioned devices shall be used in handling the item.

## **v) Cast Iron Pipes**

- A. The pipe shall at all times be handled with approved equipment designed to prevent damage to exterior coating. Bare cables, chains, hooks, metal bars or narrow skids will not allowed to come in contact with either exterior coating or interior lining.
- B. If damage occurs to any pipes, fittings, or pipe accessories in handling, the damage shall be immediately brought to the Engineer's attention . The Engineer shall prescribe corrective repairs or rejection of the damaged items .
- C. The contractor shall stand the expense of repairing or replacing the same . Coating materials ready for use shall always be kept on site when pipe laying is going on .

### vi) Glass Reinforced Polyester (GRP) Pipes

- A. Pipes 600mm and smaller may be packaged as a unit. manufacturer's instruction for handling unitized loads should be strictly followed. When handling single pipes, use pliable straps, slings, or rope to lift. Do not use steel cables or chains to lift or transport the pipe. Do not lift pipes by passing a rope through the section end to end.
- B. Maximum stack height is approximately 2 meters. Strap pipe to the vehicle over the support points using pliable straps or rope. Using steel cables or chains is prohibited without adequate padding to protect the pipe from abrasion. Also, maximum diametrical deflection must not exceed the values in Table 4.1 below.

**Table 4.1 - Maximum Storage Deflection**

Stiffness Class SN	Maximum Deflection (% of Diameter)
2500	2.5
5000	2.0
10000	1.0

- C. Bulges, flat areas, or other abrupt changes of curvature are not permitted.
- D. Unloading the pipe is the responsibility of the Contractor, he should be sure to maintain control of the pipe during unloading. Guide ropes attached to pipes or packages will enable easy manual control when lifting and handling. Spreader bars may be used when multiple support locations are necessary. Do not drop, impact, or bump the pipe, particularly at pipe ends.
- E. If at any time during handling or installation of the pipe, any damage occurs, the pipe should be segregated and not used.

### vii) Steel Pipes

- A. Considering all above mentioned general instructions, steel pipe shall be transported from the coating plant to the job site on padded bunks with nylon tie-down straps or padded banding to adequately protect the pipe and coating.
- B. The steel pipe lining must be Sulphide resistant.
- C. Coated pipe shall be handled, stored and shipped in a manner that will prevent damage to the coating. Pipe shall be handled with wide belt slings or rubber padded forklifts. Chains, cables or other equipment likely to cause damage to the pipe or coating shall not be used.
- D. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen will be permitted to walk upon the coating only when necessary, in which case they shall wear shoes with rubber or composition soles and heels. All pipe and fittings, specials and couplings shall be examined before laying, and no piece shall be installed which is found to be defective. Any damage to the coatings shall be repaired as acceptable to the Engineer.
- E. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his own expense.

## **4.2 Stacking and Storage of Pipes**

### **i) General**

- A. Pipes stored in the field shall be arranged in piles in such a manner that the pressure of the pipes placed on each other will not cause deformation of the pipe or damage to the coating.
- B. The Supply Contractor shall properly stack the pipes in the storage yard of the Employer and the stacks shall be laid out in a regular pattern and the limits of each stack marked to that the movement of cranes and vehicles is restricted to access tracks between stacks and the control of delivery and removal pipes is facilitated.
- C. The number of tiers of steel and ductile iron pipe stacks shall be as per the Manufacturer's instructions and approval of the Engineer and each pipe, including those in the bottom course, shall bear evenly upon not less than three timbers with an aggregate width not less than 300 mm. The pipes shall be stacked parallel to each other and arranged so that in each course all sockets are at one side and in the next course all spigots are on the other side.
- D. The timbers supporting each course of pipes in a stack shall be of uniform thickness and stiff enough for the pipes to be rolled across the stack and shall be supplied by the Contractor at his own expense.
- E. The outermost pipes in each course shall be secured against rolling by sandbags or by wedges.
- F. Where the pipes are to be delivered and stacked by the Supply Contractor on designated sites lying on the pipeline route, unless it is otherwise specified elsewhere, the areas where the pipes are to be stacked shall, if required, be graded flat by the Supply Contractor at his own expense to provide a firm even surface, and kept free from loose stones, rubble or waste liable to damage the pipe coating.

### **ii) Ductile Iron Pipes**

- A. Materials, when stored, shall be kept safe from damage. The interior of all pipe, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.
- B. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Pipe in tiers shall be alternated. At least two rows of 100mm x 100mm (4 in x 4 in) timbers shall be placed between tiers and chocks affixed to each end in order to prevent movement.
- C. Gaskets for mechanical and push-on joints to be stored shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

### **iii) Concrete Pipes**

- A. In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench.
- B. The Contractor shall keep the pipe and appurtenances clean during the progress of the work. Dirt, debris or other foreign material shall be removed from the interior of the pipe before installation. All openings in the pipeline shall be plugged watertight with standard cast iron test plugs, expandable type sewer plugs or other means approved by the Engineer at the end of each day's operations or whenever the workmen are to be absent from the work area. The use of burlap, wood or other similar temporary plugs will not be permitted. All surface or ground water shall be prevented from entering the pipe and shall be removed from the trench. Should water nevertheless enter the trench, laid pipes shall be secured against lifting.
- C. Rubber rings for pipe joints shall be stored and protected in a proper manner to prevent deterioration.

**iv) PVC and PE Pipes**

- A. While stored, pipe shall be adequately supported from below at not more than 900mm intervals to prevent deformation. The pipe shall be stored in stacks no higher than that given in table 4.2 :

**Table 4.2 - Storage Stacks**

<u>Pipe Diameter</u>	<u>Max. No. of Rows Stacked</u>
200mm or less	5
300 to 530mm	4
600 to 760mm	3
840 to 1220mm	2

- B. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures and out of the sunlight. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature build-up or direct or indirect sunlight will not be permitted.
- C. If any defective item is discovered after it has been installed, it shall be removed and replaced with an exact replacement item in a satisfactory manner by the Contractor, at the Contractor's own expense. All pipe and fittings shall be thoroughly cleaned before installation and the interior shall be kept clean until testing.

**v) Cast Iron Pipes**

- A. The Contractor shall keep the pipe and appurtenances clean during the progress of the work. Dirt, debris or other foreign material shall be removed from the interior of the pipe before installation. All openings in the pipeline shall be plugged watertight with standard cast iron test plugs, expandable type sewer plugs or other means approved by the Engineer at the end of each day's operations or whenever the workmen are to be absent from the work area. The use of burlap, wood or other similar temporary plugs will not be permitted.
- B. Rubber rings for pipe joints shall be stored and protected in a proper manner to prevent deterioration.
- C. Material found to be defective or damaged shall be rejected and removed from the Work. Spigot ends shall be examined with particular care as this part is the most vulnerable to damage from handling. Any damage to exterior protective coatings shall be repaired before the pipe is laid in the trench. In case of damage to the interior protective coating or lining, the said pipe or fitting shall be laid aside for inspection by the Engineer, who will prescribe corrective repairs or rejection. Where a portion of a length of pipe is damaged, the damaged part shall be cut off in an approved manner and discarded and the remaining sound portion may be used. Any materials which fail or become damaged will be deemed to have been caused by the Contractor's negligence in handling and must be replaced with new or repaired as the Engineer decides without cost to the Employer.

**vi) Glass Reinforced Polyester (GRP) Pipes**

- A. All pipes should be inspected upon receipt at the job site to insure that no damage has occurred in transit. Depending on length of storage, amount of job site handling and other factors that may influence the pipes condition, the Engineer may reinspect the pipe just prior to installation.
- B. If the load has shifted or indicates rough treatment, carefully inspection should be made. Generally, an exterior inspection will be sufficient to detect any damage, but if pipe size permits, an interior inspection of the pipe surface at the location of an exterior scrape may be helpful to determine if the pipe is damaged. If any imperfection or damage is found, immediately the effected pipes should be segregated and disposed of the site.

- C. It is generally advantageous to store pipe on flat timber to facilitate placement and removal of lifting slings around the pipe. When storing pipe directly on the ground, the area should be flat and free of rocks and other potentially damaging debris. All pipes should be checked to prevent rolling in high winds.
- D. If it is necessary to stack pipes, it is required to stack on flat timber support at maximum space centers 6 meter spacing (3 meter for small diameter) with a maximum overhang of 2 meters. Chock the pipes to maintain stability and separation. Insure no pipes contact other pipes, so vibration during transport will not cause abrasion. Insure the stack will be stable for conditions such as high winds, unlevel storage area or other loads. Stacking of pipes larger than 1400mm diameter is not permitted.
- E. Rubber ring gaskets, when shipped separate from the couplings, should be stored in the shade in their original packing and should not be exposed to sunlight except during the pipe joining. Also, the gaskets must be protected from exposure to greases and oils which are petroleum derivatives, and from solvents and other deleterious substances.
- F. Gasket lubricant should be carefully stored to prevent damage to the container. Partially used buckets should be resealed to prevent contamination of the lubricant.

### **vii) Steel Pipes**

- A. Stored pipe shall at all times be supported on sand bags, or other suitable support. Bags shall be of sufficient size to prevent contact of the pipe coating with the ground or any other obstruction. Rolling the pipe on the coated surface will not be permitted.

## **4.3 Materials supplied by the Employer**

- A. In case the pipes and ancillary fittings, specials and valves are to be supplied by the Employer the latter shall supply to the contractor free of charge at his stores or at the place indicated in the Particular Conditions and Specifications, the required quantities of different pipes of various diameters together with the respective fittings, specials, adapters and valves as outlined in the Particular Conditions and Specifications and the Contractor shall load transport and unload the materials so supplied at the site of works and shall be responsible for proper unloading, stacking and storing .
- B. The pipes shall be unloaded from the trucks in an approved manner and the Contractor shall take utmost care not to damage the pipes or any of the materials so supplied. Any damage caused to the materials in loading, transport and unloading at the site of works shall be repaired by the Contractor at his own expense in accordance with the Engineer's instructions and to his satisfaction.
- C. Material irreparably damaged shall be replaced by the Contractor at his own expense or charged to his account.
- D. The Contractor shall stack the pipes in a secure, safe and approved manner and in a way to allow easy handling.
- E. Pipes found damaged before handling them over to the Contractor shall be counted and stacked by the Contractor separately each diameter aside and the damage of each pipe, shall be fully described. Such pipes shall not be used in the works unless and until the Contractor has used all the sound pipes delivered to him and is so ordered by the Engineer.
- F. The Contractor will be required to sign the vouchers for the materials supplied to him, and shall keep proper stores book to show at any time the quantity of materials received and those which have taken from the stores for use in the works. The Engineer or his representative shall have the right to inspect at any time the store books, and to check the materials in the stores and on site of works to satisfy themselves that everything is in order and the Contractor will be required to account for any discrepancy found.

- G. The Contractor shall at his own expense provide and constantly maintain day and night watching and shall be responsible for the theft or loss for any materials supplied to him by the Employer whether theft occurred from the stores or from the site of works. Any materials so found missing shall be immediately replaced by the Contractor at his expense.
- H. On completion of works, the materials used in the works shall be counted and / or measured and the balance shall be handed over by the Contractor to the Employer at his indicated storage yard. The loading, transport, unloading and proper stacking of materials shall be carried out in accordance with the relative clauses of the Specifications and shall be at the Contractor's expense.
- I. Any materials not accounted for shall be replaced by the Contractor at his own expense or shall be charged to the Contractor's account C.I.F. site plus 20% as the Engineer deems it suitable.

#### **4.4 Pipelaying in Trenches**

##### **i) General**

- A. Pipes and fittings will be installed in strict accordance with the Manufacturer's Specifications and instructions to the satisfaction and approval of the Engineer.
- B. The pipe route shall be determined by the Engineer. The Engineer reserves the right to vary or abandon any part or parts of the routes of pipelines indicated on Drawings and the contractor shall lay the pipes in accordance with any such variations which the Engineer may issue.
- C. The Contract Drawings show the approximate lines and levels to which the pipeline is to be built and are subject to amendments by the Engineer on site. Before setting out any sections of the pipeline, the Contractor or his representative shall make an inspection of the site in company with the Engineer and obtain from him his instructions in this respect.
- D. All pipes, curves, bends and other specials shall be laid accurately in accordance with the alignment, levels and gradients so determined, so that the top of the pipe is not less than the minimum specified depth below the finished ground level along the pipeline. Changes in gradient and the numbers of air valves and wash-out valves will be the minimum necessary to secure efficient operation and economy in excavation.
- E. The Contractor shall provide the surveying instruments, surveyors, skilled staff and everything necessary for setting out the works to line and level and for checking the accuracy of pipe-laying and jointing. He shall attend upon the Engineer and provide him with such assistance as may be necessary to enable him to check the setting out of the works.
- F. The finished pipeline shall run straight between bends or curves and a uniform gradient shall be accurately maintained between changes of gradient shown on the drawings or authorized by the Engineer.
- G. The bottom of the trenches shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of pipe and bell holes shall be provided. The Contractor shall inform the Engineer sufficiently in advance when the formation levels of the trenches are ready for inspection. No pipe laying will be allowed until the bottom of trenches have been inspected and approved by the Engineer and the depths of the trenches and the kind of excavation have been recorded and agreed upon by both the Contractor and the Engineer.
- H. As a general rule, water pipes and sewers should not be laid in the same trench. They should be laid in separate trenches at least 3m apart in horizontal direction. If local conditions, such as in very narrow streets, do not permit the horizontal minimum separation of 3m, this distance could be decreased but the bottom of the water pipe must be kept at least 500 mm above the top of the sewer. But if the vertical separation of not less than 500 mm can not be obtained, concrete encasement shall be provided to sewer pipe as shown on the Drawings.

- I. The pipe shall be positioned and bedded in the trenches in an approved manner and properly aligned. Before being positioned, each pipe shall be thoroughly examined to ensure that it is free from defects and shall have all dirt removed from the inside thereof. The Contractor shall cut the pipes if and where needed to the required length and shall thread, chamfer or bevel the cut ends of pipes as the case may be and shall supply and install all fittings, specials and adapters as may be necessitated for the proper execution of the works and shall joint the pipes in accordance with the Specifications and to the Engineer's Satisfaction.
- J. All pipe shall be sound and clean before laying. Good alignment shall be preserved in laying. The deflections at joints shall not exceed that recommended by the manufacturer. Fittings, in addition to those shown on the Drawings, shall be provided.
- K. Any injury to the protective coating of the pipes from any causes during the construction of the pipeline shall be repaired by the Contractor at his own expense to the satisfaction of the Engineer.
- L. At the end of each day's work a strong watertight plug or other approved means shall be firmly fixed in each open end in order to exclude all foreign materials.
- M. In order to prevent the pipes from "creeping" from the mechanical joints and to protect the welds against thermal stresses, which are specially dangerous when pipelaying is done in summer, the following instructions shall be strictly adhered to :
- N. Lowering-in and jointing of sections shall be done, as far as possible; in the early hours of the morning.
- O. As soon as the tack-welds have been completed, in the case of overhead weld joints, or as soon as the bolts have been tightened, where sections are connected by mechanical joints, the first stage backfill (between joints) shall be executed, so that no more than one section at a time will remain uncovered in the trench.
- P. Lowering-in and/or placing of welded sections on temporary supports shall be done carefully so as to prevent any damage from being done to existing coating or paint.
- Q. The method employed for lowering-in shall be subject to the Engineer's approval.

### **ii) Ductile Iron Pipes**

- A. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA C600 except as otherwise specified or shown on the Drawings.
- B. Fittings, in addition to those shown on the Drawings, shall be provided when required by the site utility conditions. When cutting pipe is required, the cutting shall be done by abrasive saw. Any damage to the lining shall be repaired to the satisfaction of the Engineer. Cut ends of pipe to be used with a bell shall be beveled to conform to the manufactured spigot end. Joints shall be made in strict accordance with the manufacturer's instructions.
- C. Restrained joint or suitable tie-rods shall be provided where there is a possibility of pulling the joint under pressure. Concrete anchors and thrust blocking shall be provided where there is thrust forces resulting from change of pipe direction in either horizontal or vertical planes. Thrust block bearing area against the soil shall be as shown on the Drawings.
- D. After installation, the pipe shall be tested for compliance with the Specifications. Furnish all necessary equipment and labor for the pressure test and leakage test on the pipelines.
- E. Submit detailed test procedures and method for Engineer's review. In general, testing shall be conducted in accordance with AWWA C600.



### iii) Concrete Pipes

- A. The pipes shall be laid accurately to line and level and jointed in an approved manner. The pipes shall be laid on the backfilled and finished bedding of the trench, and special hollows be made for the joints. The spigot part of the pipe shall be placed below the grade line to avoid any cracks between the pipe and the spigot.
- B. The whole inside and outside area forming the joint of pipe and fittings shall be thoroughly cleaned before laying. Every precaution shall be taken to prevent foreign material from entering the pipes. During laying operations, no debris, tools, cloth or other materials shall be placed in the pipe.
- C. After placing a length of pipe in the trench, the spigot end shall be centred in the socket (or corresponding) and pipe forced home and brought to correct line and grade. The pipe shall be secured in place with approved backfill material tamped under it except at the joint. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed and uniform space provided. Precautions shall be taken to prevent dirt from entering the joint space. Pipes shall be laid such that the whole body of the pipes is in contact with the bedding. All pipeline must be inspected and approved by the Engineer before they are covered.

### iv) PVC and PE Pipes

- A. No single piece of pipe shall be laid unless it is straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1.5mm per 300mm of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the manufacturer shall be explicitly followed.
- B. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Employer. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required. Pipe and fittings shall be installed in accordance with requirements of the manufacturer, and AWWA C605 or as otherwise provided herein.
- C. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. cut ends of pipe to be used with a bell shall be beveled to conform to the manufactured spigot end.
- D. The Engineer may examine each bell and spigot end to determine whether any performed joint has been damaged prior to installation. Any pipe having defective joint surfaces shall be rejected, marked as such and immediately removed from the job site.
- E. Each length of the pipe shall have assembly mark aligned with the pipe previously laid and held securely until enough backfill has been placed to hold the pipe in place. Joints shall not be "pulled" or "cramped". Deflection in horizontal or vertical alignment shall not be performed without the approval of the Engineer's Representative as to the extent of the deflection. In no case shall such deflection be done at the pipe joint. If any bending is required it should be done at the central portion of the pipe and not exceeding the limits specified by the manufacturer. Whenever the required deflection exceeds the permissible limits, the contractor shall install proper bends in the line and anchor same as required. Care should be exercised to lay the pipe in such manner as to minimize the high and low points in it.
- F. Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it. Bell or coupling holes shall be formed so that, upon being placed only the pipe barrel is in contact with the trench bottom.
- G. Jointing of PE pipes will be made using electro-fusion method. During jointing with electro-fusion, care should be taken that joints are not moved before the cooling process has been completed.



- H. For PVC pipes, flexible joints with spigot and sockets sealed with rubber rings or gaskets will be used. Spigot ends shall be centralized within sockets, and shall be pushed into the socket, strictly following the manufacturer's instructions, until reach the depth of the entry mark. The pipe should never be over inserted.
- I. Precautions shall be taken to prevent flotation of the pipe in the trench.
- J. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below top of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, pipe bedding shall be placed to fill any voids created and the backfill shall be recompacted to provide uniform side support for the pipe.
- K. Joints shall be made in strict accordance with the manufacturer's instructions.

### **v) Cast Iron Pipes**

- A. The pipes shall be laid accurately to line and level and jointed in an approved manner. The pipes shall be laid on the backfilled and finished bedding of the trench, and special hollows be made for the joints. Socket pipes shall normally be laid with the socket at the higher end to facilitate the making of the joints. Supporting wooden construction shall not be placed under pipes .
- B. The whole inside and outside area forming the joint of pipe and fittings shall be thoroughly cleaned before laying every precaution shall be taken to prevent foreign material from entering the pipes. During laying operations, no debris, tools, cloth or other materials shall be placed in the pipe.
- C. After placing a length of pipe in the trench , the spigot end shall be centered in the socket (or corresponding) and pipe forced home and brought to correct line and grade. The pipe shall be secured in place with approved backfill material tamped under it except at the joint. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed and uniform space provided. Precautions shall be taken to prevent dirt from entering the joint space. Pipes shall be laid such that the whole body of the pipes is in contact with the bedding. All pipeline must be inspected and approved by the Engineer before they are covered .

### **vi) Glass Reinforced Polyester (GRP) Pipes**

- A. GRP pipe, like virtually all pipe made with petrochemicals, can burn and is, therefore, not recommended for use in applications which are exposed to intense heat or flames. During installation, care must be taken to avoid exposure of the pipe to welder's sparks, cutting-torch flames or other heat / flame / electrical sources which could ignite the pipe material. This precaution is particularly important when working with volatile chemicals in making lay-up joints, repairing or modifying the pipe in the field.
- B. The type of installation appropriate for GRP pipe varies with pipe stiffness, cover depth and native soil characteristics. The native material must adequately confine the pipe zone backfill to achieve proper pipe support. However, the designated type of installation, as stipulated by the manufacturer shall be followed, and consequently, the permissible must not be exceeded.
- C. The bed must be over-excavated at each joint location to ensure that pipe will have a continuous support and does not rest on the coupling. However, this area must be properly bedded and backfilled after the joint assembly is completed.
- D. GRP pipe sections are typically joined using double bell couplings. Other jointing systems such as flanges, mechanical coupling and lay-up joints may also be used with GRP pipes.

- E. The manufacturer's instructions for installation should be strictly followed. The coupling grooves and the rubber gasket rings must be thoroughly cleaned to insure no dirt or oil is present. Insertion the gasket into the grooves should be done with uniform pressure to insure for well distributed compression of the gasket. Tapping with rubber hammer will be helpful to use. Next, using a clean cloth, apply a thin film of lubricant to the rubber gaskets as per manufacturer's instructions. Petroleum base lubricant shall not be used.
- F. Immediate backfilling after joining is desirable as it will prevent two serious hazards - floating of pipe and thermal movements. During backfilling, the granular material should flow completely under the pipe to provide full support. A blunt tool may be used to push and compact the backfill under the pipe, without raising the pipe up. Proper backfilling compaction of each layer is important to ensure that the pipe will have an adequate support. Care must be taken to avoid excessive compactive effort above the pipe crown, which may cause bulges or flat areas.

### vii) Steel Pipes

- A. The Contractor shall regulate his equipment and construction operations such that the loading of the pipe does not exceed the loads for which the pipe is designed and manufactured.
- B. Except as otherwise provided herein, pipe and fittings shall be installed in accordance with the requirements of AWWA M11.
- C. The Contractor shall permit and aid in the inspection of the coating on the underside of the pipe at the time of installation and shall repair any damage before lowering the pipe into the trench. While being laid, the pipe shall not be rolled, skidded, or otherwise moved, when it contacts with the ground at any point.
- D. The method of jointing the pipe shall be in strict accordance with the manufacturer's instructions. The Contractor shall arrange for the manufacturer to supervise the installation of at least the first three standard joints and the first restrained joint. Pipe shall be laid with bell ends upstream, unless otherwise approved by the Engineer.
- E. As soon as the pipe is in place and before the come-along (if used) is released, granular fill shall be placed to the top of the pipe for at least one half the length of the pipe. Not until this backfill is placed shall the jacks or come-along (if used) be released. If any motion at joints can be detected, a greater amount of backfill shall be placed before pressure is released.
- F. Before bedding of galvanized pipes, in situ cold bitumen coating, of minimum thickness (0.5 mm) should be applied for underground installations, and extended at least 200 mm for pipes partially laid above the ground.
- G. Field joints shall be wrapped in accordance with AWWA C209. The joints shall be cleaned, primed and wrapped with two wraps of tape with a 0.89mm (35 mils) thickness each and holiday tested. When the alternative extruded polyethylene coating is used, field joints shall be coated in accordance with AWWA C216.
- H. The Contractor shall have on hand a sufficient supply of assorted short pipe lengths, adapters and any other fittings necessary to prevent delays in pipe laying.
- I. Restrained joints shall be installed to the limits indicated on the Drawings or as directed by the Engineer in accordance with applicable provisions of the above. Restraining shall be harnesses coupling or field welded.
- J. Pipes shall be installed true to alignment and with rigidly supported anchors adequately designed for the worst loading conditions. After installation, the piping shall be tested in accordance with applicable provisions of AWWA C600.

## 4.5 Pipe Welding

### i) Welding Methods

- A. All welds shall be made by the manual shielded metal-arc method. The welding procedure to be applied by the Contractor shall be submitted to the Engineer for approval before any commencement of the Work. All requirements as to the quality of the welds shall apply equally to roll welding and position welding. All welds shall be made only by welders having passed the welders' qualification test. The Contractor will not be allowed to use a piece-work system on welding work, but there shall be no limitations to the amount of work a welder may produce during one day, provided that the welds meet all the requirements of the specification.
- B. The use of welding machines with two outlets will not be permitted; every welder shall work with his own machine.

### ii) Electrodes

- A. Electrodes used on welding work shall have a diameter of 4 mm and 3.25mm and shall approximately meet the requirements of ASTM Specification A 233 as last revised. Generally, with D.C. generators, class S 6010 electrodes shall be used. In any event, the electrodes proposed by the Contractor shall be subject to the Engineer's approval prior to their use.
- B. Electrodes shall be stored in unopened original containers in such a manner as to prevent absorption or loss of moisture or mechanical damage to the coating. Electrodes in open containers shall be protected against moisture. Electrodes that have been damaged, become moist or otherwise deteriorated shall be rejected.

### iii) Cleaning of Pipes

- A. Pipe ends to be welded together shall be thoroughly cleaned of any dirt, oil, residues of paint and asphalt, and any other foreign matter that may adversely affect the quality of the weld. Paint and oil residues shall be removed with kerosene or benzene.
- B. Before welding the root bead, the cleaning pig with the cable attached to it shall be introduced into the pipe last laid before the new pipe. When the root bead has been completed, the pig shall be extracted by means of the cable; in passing the seam the pig will remove all metal bubbles and slag that have entered the interior of the pipe.

### iv) Welding Positions

- A. The welds shall be made either by roll welding or position welding. Roll welding will be permitted, provided alignment is maintained by the use of skids and roller dollies supporting two or more lengths of pipe. Position welding shall be done with the pipes resting on skids at the proper height over or alongside the trench, so as to permit completing the weld on the whole circumference.

### v) Weather Conditions

- A. No welding shall be done when adverse weather conditions such as rain, mist, sand storms, or strong winds may affect the quality of the welds. The Engineer will decide in each case whether weather conditions permit welding to be done.

### **vi) Cutting and Preparing Pipes for Welding**

- A. The cut shall be made with an approved mechanical pipe cutter and in conformity with the pipe manufacturer's recommendations. The edges of the cut shall be clean, true and square. The edges of the cut together with those parts of the pipes from which the coating has been removed shall be given two coats of bituminous paint and the internal lining repaired, if damaged, to the approval of the Engineer. When the cut pipe is to be inserted in a "Tyton" type joint it shall be beveled for 10 mm at 30° to pipe axis to remove sharp or rough edges.
- B. The Contractor shall be solely responsible for the provision of all equipment necessary for cutting and preparing pipes.
- C. Spare cut lengths shall as far practicable be used elsewhere in the pipeline.

### **vii) Welding of Joints**

- A. The number of beads in each weld seam shall not be less than two, and their thickness shall not exceed 3.0mm.
- B. In butt welds, the thickness and number of the beads shall be so adjusted that the height of the weld reinforcement shall be not less than 0.8mm and not more than 1.5mm above the pipe surface. The width of the cover bead shall be approximately 3.0mm more than the width of the groove before welding. In fillet welds the thickness of the throat shall be at least (0.707) of the pipe wall thickness cutting back of the edge of the bell shall be kept to a minimum. All weld metal shall be thoroughly fused to the parent metal and to the previously placed weld metal.
- C. After the completion of each bead, the weld shall be thoroughly cleaned of all scale, slag, or dirt. All spots on the weld where electrodes are changed shall also be cleaned.

### **viii) Jointing of Line Sections**

- A. Pipes shall be connected to each other by welding as specified above, while they are placed on suitable supports on the trench bottom or on the ground beside the trench. The places of welded joints should be wrapped according to the instructions of the manufacturer.
- B. The length of sections to be welded together before lowering shall be as determined by the Engineer. The position of every pipe or elbow in the section shall be such that, when the section has been lowered to the trench bottom, the longitudinal seams will be located between the figures 10 and 2 on the clock face, so that repairs on the seams can be done in the trench without necessitating deep excavation.
- C. Before being connected to the line, each pipe and each elbow shall be cleaned on the inside.

### **ix) Repair of Weld Defects**

- A. The Engineer may permit repairs of defects in the root or filler beads to be made, but any weld that shows evidence of repair work having been done without such permission may be rejected.
- B. Pinholes and undercuts in the final bead may be repaired, but such repairs shall be subject to the Engineer's approval. Undercuts not exceeding 1.0mm in depth will not be considered as defects.
- C. Before repairs are made, the defective areas shall be removed by chipping, grinding, or flame gouging. All slag and scale shall be removed by wire brushing. When cracks are found, the entire seam shall be cut and rewelded.

- D. The Contractor shall clearly mark with oil paint on top of the pipe any defect that may be discovered in the pipe or weld.

### **x) Radiographic Tests**

- A. Radiographic tests shall be performed at locations specified by the Engineer of weld seams. If these primary tests should not give satisfactory results, the Engineer will conduct additional radiographic tests to ascertain the quality of the welding work. All weld defects discovered by the tests shall be repaired as directed by the Engineer and all repaired welds shall be retested.
- B. The routine radiographic tests will be carried out at the Employer's expense. Should, however, the Engineer assess it necessary to conduct additional tests because of the defective quality of the welds, the cost of all such additional tests will be charged to the Contractor's account. The Contractor shall also bear the cost of repair of all welds found defective under test as well as the cost of resetting such repaired welds.

## **4.6 Above Ground Pipelaying**

- A. In addition to all specifications here before mentioned for each type of , the following instructions shall be considered for the above ground pipes :
- a) All pipes and fittings exposed to view shall have its surface prepared, finish painted and marked in accordance with the manufacturer's instructions and as required by the Engineer in identifying pipe contents, direction of flow and all else required for proper finish painting and marking of pipe.
  - b) Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and jointing method and their locations shall be verified from approved piping layout drawings and structural drawings.

## **4.7 Joints Installation**

### **i) General**

- A. Joints shall have natural or synthetic rubber rings maintained in place in such manner as to ensure watertight joints during the specified tests, and the subsequent life of the installed pipes. The ring shall be highly resistant to deterioration in contact with sewage.
- B. The joint material shall further more comply with the requirements of the B.S, ASTM or DIN.
- C. No cementitious or adhesive material shall be used to construct or make repairs at the joints.

### **ii) Flanged Joints**

- A. The flanges shall be scraped clean and correctly positioned and the component parts including any insertion ring cleaned and dried. Insertion rings shall be fitted smoothly to the flange without folds or wrinkles. The faces and bolt holes shall be brought fairly together and the joints shall be made by gradually and evenly tightening bolts in diametrically opposed positions. Only standard length spanners shall be used to tighten the bolts.
- B. The protective coating, if any, of the flange shall be made good when the joint is completed.

### **iii) Mechanical Joints**

- A. Before installing mechanical joints, the pipe ends shall be cleaned of any paint, asphalt and dirt and their perfect roundness shall be ensured for a distance of not less than 200 mm from the edge.

- B. Joint rings shall slide freely into the pipes. Forcing on of rings by hammer blows will not be permitted.
- C. Rubber gaskets shall be protected against sunlight until immediately before installation. Where a “bored Dresser” is required, the ridge in the central ring shall be removed by turning on lathe in the shop or by chiseling if the work is done in the field. Removing the ridge by flame gouging is strictly prohibited.
- D. Where shown on the drawings or required by the Engineer, Dresser couplings shall be fitted with anchors. The shape and method of installation of these anchors shall be as shown on the drawings.
- E. Every Dresser coupling shall be bridged for cathodic protection as shown on the drawings (see clause 6.2).

#### **4.8 Fabrication of Steel Fittings**

- A. Fabrication of fittings by welding pieces of pipes is not accepted. The fabrication shall be done as follows :
  - a. Elbows must be fabricated by forging or by hot or cold forming of pipes.
  - b. Reducers must be fabricated by hot or cold forming and annealing of pipes.
  - c. Tees must be fabricated by forming of pipe or by hot or cold forming and annealing of pipes.
  - d. Caps must be fabricated by hot or cold stamping or forging of plates heat treated.The fabricated pieces shall be of the same thickness as the used pipe .

#### **4.9 Connections to Existing Mains**

- A. Where connections are to be made to any part of the existing mains the Contractor must make all necessary arrangements with the Engineer and have all necessary material, plant and labour in readiness on the ground and shall complete the work as rapidly as possible with the minimum of inconvenience to consumers. The actual connection to an existing main will be the Contractor under the close supervision of the Engineer.
- B. All connections to an existing main should be through manholes.

#### **4.10 House Connections**

- A. House connection shall be extended inside the property of the customer at a distance of 1m inside the lot of the satisfaction of the Engineer. The pipe should be sleeved with a suitable sleeve material where it passes through the boundary wall and as indicated on the Drawings.
- B. A stop valve shall be installed adjacent to the meter on the entry side as indicated on the Drawings, to work as an isolating valve for maintenance purposes.
- C. The Engineer will issue instructions regarding size, location and fittings for each service connection.
- D. All service connections shall be subjected to a hydrostatic pressure test in the presence of the Engineer's Representative. Sterilization of the service connection will be carried out at the same time as the main to which it is connected.

#### **4.11 Protection of Joints**

- A. All buried steel and ductile iron flange joints, flange adapters and couplings shall be protected by wrapping with “Denso Tap” or similar approved material.
- B. The joints shall be thoroughly cleaned to remove all loose rust and extraneous matter and thoroughly and adequately wrapped with the protective tape to the satisfaction of the Engineer.

## 4.12 Hydrostatic Test

### i) General

- A. After completing the installation of a sewer line or a section of the line, and before backfilling is carried out, a hydrostatic test of the line shall be made.
- B. The test pressure shall be 1.0 meter head of water at the highest point of the section under test. The length of each section to be tested shall not exceed 100 meters and the pressure at the lowest point shall not exceed 10 meters head of water for gravity lines.

### ii) Procedure

- A. Whenever possible, testing of sewers shall be carried out from manhole to manhole. Short branch sewers connected to a main sewer between manholes may be tested as one system with the main sewer. Long branch sewer shall be tested separately.
- B. Both ends of the Sewer to be tested, as well as inlets and outlets to manholes and other connections in between shall be sealed effectively. At the upper end of the sewer a gauge glass shall be connected to the sealing plug to enable the observation of the water level during the test. The gauge glass should have an inner diameter of about 50 mm and shall be provided with a mark located at 1.0 meter above the top of the sewer. An air vent and a cock should also be installed at the same end for release of air during the filling of water for the testing. The air vent shall be connected to the sewer so that all air can be released. The trench shall be kept free of all kinds of water during the test.

### iii) Duration of Test

- A. The pipe shall be filled with water for a period of minimum 2 hours and maximum 24 hours before the test is assumed to begin to allow for a soaking period and a complete release of air. If 25 hours have passed with water in the pipe, filled or partially filled, without being tested the pipe should be emptied completely and left for 24 hours and then filled again with water and tested within 2-24 hours soaking period. The water level shall be at the mark on the gauge glass during the whole soaking period. The test shall be carried out immediately after the soaking period.

### iv) Permissible Leakage

- A. Leakage is defined as the quantity of water which must be supplied to the laid pipe during 10 minutes to maintain the specified water level after the pipe has been filled with water and the air expelled. The additional quantity of water filled into the pipe shall be measured with an accuracy of 0.1 litres.
- B. The sewer will be accepted in respect of water tightness if the quantity of water added during 10 minutes is less than quantity calculated in accordance with the following clauses (v) and (vi).

### v) Sewer Line With One Pipe Dimension

- A. The maximum permissible quantity of water which may be supplied to the line during the test is estimated as follows :

$$Q = (0.118) (L) (d)$$

Where Q = quantity of water in litres during 10 minutes

L = length of line in meters

d = inner diameter of pipe in meters

- B. The maximum permissible leakage in manholes is estimated as 0.35 liters per 10 minutes per meter diameter per meter depth of water inside the manholes.

### **vi) Sewer Line With Different Pipe Dimensions**

- A. At sewer lines with more than one pipe dimension the maximum permissible quantity of water Q total, which may be supplied to the line during the test is estimated as follows :

$$Q_{\text{total}} = Q_1 + Q_2 + \dots + Q_n$$

Where Q total = quantity of water in litres during 10 minutes

Q1, Q2, Qn = quantity of water for respective pipe dimension estimated according to clause (v).

### **vii) Extent of Testing**

- A. The Contractor shall provide at his own expense all equipment, labour, and materials necessary and carry out testing of 100% of the total lengths of the lines included in the works before covering the pipes. House connections and manholes are not included. 50% percent of the manholes should be tested separately or with the line.
- B. Manholes shall be tested before benching is made in manholes and before backfilling and after installation of the steps. A maximum of 5% of the lines shall be tested including house connections after backfilling is complete.
- C. The lines to be tested shall be chosen by the Engineer. should any line tested before backfilling exceeded the permissible Q by more than 5% the Contractor shall after repairing and making good any leaks carry out further tests all as above described and within the specified soaking period. If it continues of fail by more than 5% of permissible Q at the end of the soaking period, the line should be dismantled and reconstructed with new pipes and should be retested, all at the Contractor's expense.
- D. The same proceduse is applied for lines and house connections that are tested after backfilling but with a tolerance of 15% of permissible Q. Repair and making good, referred to above, is to correct the alignment, level of the pipes or to fix properly any two pipes. Brushing, grouting, cementing or concreting is not allowed neither before nor after the test is run. All tests and retests and repairs shall be at the expense of the Contractor.

## **4.13 Field Air Test**

### **i) General**

- A. An alternate leak test for sewerage pipe systems may be conducted with air pressure instead of water, if instructed by the Engineer due to shortage of water for testing.
- B. Field air test is a low pressure air test which determines the rate of which air under pressure leaves an isolated section of the pipeline. This rate indicates the presence or absence of leaks.

### **ii) Procedure**

- A. As with the hydrotest, the section of pipe together with its connected ends of all bends, laterals and wyes should be plugged and braced against internal pressure. One of the plugs provided must have an inlet tap or



other provisions for connecting an air hose, the other end of the hose to be connected to the portable air control equipment.

- B. Slowly pressurize the system to 24 kPa. The pressure must be regulated to prevent over pressurization (maximum 35 kPa). Allow the air pressure to stabilize for at least 2 minutes while maintaining the pressure at 24 kPa. During this stabilization period, with soap solution detect any possible leakage. If any plug is found to leak, bleed off the air, tighten the plug and start again.
- C. After the stabilization period, adjust the air pressure to 24 kPa and shut-off or disconnect the air supply.
- D. The pipeline passes this test if the pressure drop is 3.5 kPa or less during the time periods given in Table 4.3 below.

**Table 4.3 Test Time - Field Air Test**

Dia. (mm)	Time (min.)	Dia. (mm)	Time (min.)
100	2 1/2	1000	25
150	3 3/4	1100	27 1/2
200	5	1200	30
250	6 1/4	1300	32 1/2
300	7 3/4	1400	35
350	8 3/4	1500	37 1/2
400	10	1600	40
500	12 1/2	1800	45
600	15	2000	50
700	17 1/2	2200	55
800	20	2400	60
900	22 1/2		

### iii) Safety Requirements

- A. Considerable potential energy is stored in a pipeline under pressure. This is particularly true when air (even at low pressure) is the test medium. Take great care to ensure that the plugs are properly secured. It is also obvious that the pressure in the pipe is completely relieved before the plug is loosened.
- B. Under no circumstances should a person be allowed to be inside a manhole while the air pressure is applied to the pipelines

## 4.14 Hydrostatic Pressure Test

### i) General

- A. The pressurised sewers will be tested by a hydrostatic pressure test. After pipelaying, casting of concrete structures on the line and partial backfill have been completed, the line shall be subjected to a hydrostatic pressure test. The line shall be tested over its entire length or, in the case of long lines, in sections. The pressure test shall only be performed in the presence of the Engineer.
- B. The test pressure shall be determined by the Engineer in each case. The required pressure shall be obtained by means of a special pressure pump or by connecting the line to a suitable source of pressure.

## ii) Preparations for Pressure Test

- A. Filling of the line with water shall not begin until 6-7 days after the last concrete structures have been cast. Prior to filling the line, all joints and structures shall be inspected and the good condition and proper functioning of all valves shall be ascertained. When testing a section not ending in a valve, the open end shall be bulkheaded and securely anchored. The testing installation and the working of the pump shall also be examined.

## iii) Filling the Line with Water

- A. The line shall not be filled until the Engineer's written approval thereto has been given. The line shall be filled gradually and slowly in order to prevent water hammer or chattering in the pipe and to permit the escape of all air from the pipeline.
- B. At the commencement of filling, all blowout valves shall be open, and each valve shall be closed after the water has flushed all dirt that may have accumulated in the pipes.
- C. After the filling has been completed, but before the pressure is raised, all valves shall be inspected for water-tightness and all leaks in gaskets and stuffing boxes shall be stopped. Should this inspection show any leaks at the joints or defects in the valves that can not be repaired while the line is full of water, the line shall be drained and the necessary repairs done. This inspection shall be repeated until all leaks are stopped.

## iv) Pressure Test

- A. The pipelines of the transmission and water distribution system and all the joints shall be tested by the Contractor at a test pressure as shown in table 4.3 below:

**Table 4.3**

Working Pressure Range [atm]	Factor *
0 - 12	1.5
13 - 20	1.25
more than 20	1.1

$$\text{Test pressure} = \text{Working pressure} * \text{Factor}$$

The testing shall be carried out in sections as the pipes are laid.

- B. The length of sections and the procedure of testing shall have the prior approval of the Engineer. The Contractor shall furnish and fix on the pipelines at locations indicated by the Engineer Tees provided with 1/2" stop-cocks for the purpose of releasing the air from the pipelines. After pressure testing of the lines the stop-cock shall be removed and the opening properly plugged.
- C. An efficient stop and strutting block shall be placed at the end of the section to be tested. After the pipes have been completely filled with water and all air has been excluded therefrom, the pressure shall be raised by pumping to the specified test pressure as instructed by the Engineer.
- D. The pipeline shall be maintained under this pressure for a period of 24 hours, during which period the pressure shall not be allowed to fall below 75% of the test pressure but shall be restored to the full test pressure by such pumping as may be necessary.

- E. The test pressure shall be calculated as one and a half times the maximum working head at the lowest point in the section to be tested.
- F. The test shall be deemed to be satisfactory if the pipeline holds after the initial 24 hours the specified pressure for a final period of not less than two hours or such final period as is determined on site by the Engineer, with a loss not exceeding (5%) of the total test pressure during this two hours period. No pumping shall be permitted during this final test period.
- G. If the test is not successful, the Contractor shall proceed to locate immediately and rectify the defects, after which he shall re-test until a satisfactory test result can be secured.
- H. The Contractor shall provide the clean water, all pumps, meters, pressure gauges and other appliances required for the purpose of the test. The Contractor shall also arrange for meters and gauges to be tested for accuracy, if required to do so by the Engineer.

#### **4.15 Measurement and Payment**

##### **i) Pipes and Fittings**

- A. The construction of sewers of the sewerage collection system and the installation of house connections shall be measured and paid for by the meter run respectively for every kind of pipe and diameter of completed and accepted works in accordance with the Drawings and Specifications to the satisfaction of the Engineer and the unit price for each shall include but not limited to the following :
  - 1. The supply and laying and/or the collection and hauling from the Employer's stores to Site of Work, laying and proper jointing the respective pipeline including all fittings and specials and all incidentals required for the proper laying and completion of the relative pipeline and service lines and connections in accordance with the Drawings and Specifications.
  - 2. All ancillary works relating to the construction of sewerage collection system which are not explicitly mentioned in the Contract but could be inferred therefrom or which are customarily performed or evidently necessary to carry out the intent of the Drawings and Specifications and all other liabilities and obligations set forth in the tender Documents.

##### **ii) Manholes**

- A. The supply and erection of manholes and their necessary incidentals. This will be executed in full details according to the Drawings and Specifications and to the interactions of the Engineer's Representative. The measurement and payment will be made for the completed installed and accepted piece respectively for every type and diameter of the manhole.

##### **iii) Hydrostatic Tests and Air Field Test**

- A. The supply of water, pumps and the necessary equipment for execution the hydrostatic testing of the lines, or the source of compressed air, the control equipment and the necessary equipment for execution the field air testing of the lines. The payment will be made on a lump sum basis for the testing of the whole project sewerage system.