WATERFUND | MANDWASCO | MANDERA COUNTY GOVERNMENT | EUROPEAN UNION

ENDING DROUGHT EMERGENCIES – CLIMATE PROOFED INFRASTRUCTURE FOR IMPROVED WATER SUPPLY AND SANITATION IN ARID AND SEMI-ARID LANDS (ASALs)

PROJECT NAME: **PROPOSED CONSTRUCTION OF BOKOLOW BANYOLEY 120,000M3 EARTH PAN AND ASSOCIATED WATER SUPPLY WORKS, MANDERA COUNTY**

TENDER NO: **MCG/MANDWASCO/WSTF/ONT/01/2020-2021**

Employer:	**Funding**	
Chief Executive Officer Mandera Water and Sewerage Company P. O. Box 341- 70300 MANDERA	Chief Executive Officer Water Sector Trust Fund P.O. Box 49699-00100 NAIROBI	Chief Officer, Department of Water, Environment, Natural Resources & Energy County Government of Mandera P. O. Box 341- 70300 MANDERA

SEPTEMBER 2020

SPECIFICATION AND PERFORMANCE REQUIREMENTS

Contents

1. GENERAL

1.1 General introduction

This contract is for the construction of an Earthen water pan including a offtake infiltration gallery, Elevated Storage, Solar Powered water pumping Equipment and a distribution system to the neighbouring settlement.

1.2 Location of the works

The proposed Bokolow Banyole Earth Pan project is located in Barwako location in Central Division of Mandera East Sub-County in the County of Mandera.

1.3 Scope of Works

The works to be executed under this Contract comprise:

a) 120,000m^3 Water Pan and associated Auxiliary works
b) 50m^3 Elevated Water Tank
c) 2 No. Sanitation Blocks
d) 2 No. Cattle troughs
e) 2No. Masonry Water Kiosks

1.4 Particular specification

These general specifications together with the specific specification contained in the bills of quantities and the contract drawing will form the specification for the construction works

1.5 Provision of equipment, material and labour

The contractor shall provide all equipment, transport consumable materials and labour necessary for the satisfactory completion of the works in compliance with the specifications herein. The Engineer reserves the right to inspect plant and materials prior to contractor selection and may reject plant or material that in his/her opinion is substandard or inappropriate. The contractor shall provide full descriptions of all plants to be deployed for these works. The contactor shall also present method statements describing in detail the proposed approach to work.

The contactor shall provide summary detail of the experience of key personnel to be deployed for these works.

1.6 Occupation of site

The employer will provide land on which the works shall be constructed. The contractor shall be given possession of such parts of the site that he requires for activities related to construction works including storage of raw materials, equipment and setting up of camp during the period of contract provided his operation does not interfere with the daily activities of the local community.

The Contractor shall not enter upon or occupy with men, tools, equipment and materials any land other than the land or right of way provided by the employer

1.7 Diligent performance

The contractor shall at all times perform the Works diligently and in accordance with sound professional practice. He/she shall not proceed from one stage of works to another without the express permission of the Engineer.
Decisions regarding Temporary halt, discontinuing of any element or part of any element of these works, or abandonment of these works, shall be discussed jointly between the contractor and the Engineer before any further actions are authorised by the Engineer. The Engineer's decision shall be final.
The Engineer will require a written submission justifying any steps taken by the Contractor taken without the Engineer's approval. An unsatisfactory explanation shall lead to non-payment for works undertaken without prior agreement and may be included for consideration as liquidated Damages.

1.8 Units of Measurement

The Contract shall be conducted in the Systems International d'Units (SI) system of units in accordance with the provisions of ISO 31 and ISO 1000.

1.9 British Standards BS

"B.S." followed by the reference number and date of issue where appropriate, shall refer to the latest British standard for the quality and/or workmanship of the items described. Material required to conform to a particular B.S may be obtained from any country provided it complies with the minimum requirements of the relevant B.S.

1.10 Drawings

The project drawings shall comprise
The drawings listed in Section I of the tender documents
Such other drawings and/or sketches as are issued from time to time by the Engineer to deal with design modifications in response to on-site conditions.

1.11 Record drawing

As the work proceeds the Contractor shall mark-up 'As Built' details on a set of prints of the contract Drawings modified to portray the works as actually constructed and issue to the Engineer's representatives for approval within 7 days of completion of the works covered by each drawing.

1.12 Level datum

It shall be the responsibility of the Contractor before commencing work to obtain from the Engineer in writing the values and locations of the benchmarks to be used in these works. All temporary benchmarks shall be referred thereto. The Contractor shall construct such temporary benchmarks as the Engineer may direct and shall agree the levels thereof with the Engineer. The establishment of such temporary benchmarks shall be deemed part of the Contractor's responsibility in setting out the works.

1.13 Setting out

The Contractor shall appoint and employ the necessary qualified and experienced staff to set out the works accurately.
The Contractor shall establish and locate all lines and levels and be responsible for the correct location of all works.

Where directed by the Engineer, the Contractor shall take such levels and dimensions as may be required for the purposes of measurement before disturbance of the ground. These shall be agreed between the Contractor and the Engineer in writing before any ground surface is disturbed or covered up. Any work commenced without taking the said levels and dimensions shall be measured on the Engineer's recording of their values before disturbance. The Engineer's decision on this matter shall be final.

1.14 Construction and checking of work

The Contractor shall be solely responsible for and shall provide all labour, tools, lifting tackle, and other equipment required for the construction and checking of the works.
No operative shall be allowed to execute any type of work which is normally carried out by a skilled tradesman, unless the operative is thoroughly experienced and proficient in the trade concerned. Supervisors and operatives may be required to demonstrate their proficiency or produce certificates of competence to the satisfaction of the Engineer.
As each part of the work is carried out, it shall be subject to the approval of the Engineer.

1.15 Supervision and labour

The Contractor will be required to maintain a competent supervising Foreman on Site throughout the construction period until completion of the works, and thereafter as may be required during the Defects Liability Period. The Engineer shall give prior approval to the appointment of this Foreman and shall have the authority to withdraw this approval at any time in accordance with the Conditions of Contract.
All staff and labour employed on the works shall be employed in accordance with the labour and employment laws and regulations of the Republic of Kenya.

1.16 Priority to Local Labour

The Contractor shall give priority to the local community when hiring unskilled and skilled labour. The recommended proportion of local labour to the total workforces will be as follows;

a) Unskilled labour 80%
b) Semi-skilled labour 60%
c) Skilled labour 20%

1.17 Contractor's site offices, staff, workshops, storage and working areas, communication, etc.

The contractor together with the community shall identify appropriate location to be used by the Contractor to establish the site office, workshops and for storage. Responsibility for the compounds security will however remain with the contractor until handover. The contractor shall advice the Engineer at which of his offices any notices may be served in accordance with the conditions of contract.

1.17.1 Language of correspondence and records

All communication from contractor to the Engineer and the Engineer's Representative shall be in English language.
All site books, time sheets, records, notes drawings, documents, specifications etc. shall be in English language

1.17.2 Contractor's duty staff & offices

At least one responsible representative of the contractor shall be immediately available at all times and he shall be on site during normal working hours.
To such representative shall be delegated full authority to confer with Engineer's Representatives or his deputy and to take all steps and to issue all those instructions which may be required in an emergency to ensure the safety of all personnel of the works and of all the Employer's and other property on the site and in the immediate vicinity thereof. The Engineer's Representative may from time to time at his discretion after taking into consideration all the prevailing conditions allow some relaxation of this clause but such relaxation shall be made only with his written permission and subject to any special conditions which he may then require.
The contractor shall maintain at the site, offices for the use of representative and to which written instructions by the Engineer's Representative can be delivered. Any instructions delivered to such offices shall be deemed to have been delivered to the contractor.

1.17.3 Demolition of contractor's temporary structures

The Engineer may at any time before the end of the period of maintenance give the contractor notice in writing to demolish and remove those buildings and works which are no longer required, whereupon the title to such buildings and works and materials connected therewith shall revert to the contractor. After the demolition and removal of building and works as required by the Engineer, the contractor shall level, clear, restore and make good the sites and surrounding ground and fill in and compact all latrines, drains, pits and similar works leaving the satisfaction of the Engineer's Representative.

1.17.4 Public Relations

The contractor shall designate within his site organization competent staff whose responsibility shall be to ensure good relations.
The location of all yards, stores, workshops, offices, etc. shall be agreed beforehand with the Engineer's Representatives and shall be such as to avoid obstruction and nuisance to public and/or the client.
The contractor shall provide and maintain at or near the site suitable and sufficient shelters, mess rooms, washrooms, latrines etc. as are necessary and customary, to the satisfaction of the Engineer and in accordance with the law and regulations of the relevant authorities.

1.18 Definition and use of the Site

1.18.1 Definition of the Site

The Site shall include all those areas of land which, being public or private:
Are being provided by the Employer for the construction of the permanent works.

- Are being provided by the Employer for temporary works, including camps, offices and stores.
- Are acquired, leased, or operated by the Contractor as borrow pits or spoil tips for the permanent works, including all access roads.

1.18.2 Use of the Site

Access to the Site is gained from public and private roads. The Contractor shall be responsible for maintaining all existing site roads affected by his work while he is on Site. He shall also be responsible for repairing and making good any damage to these

roads. If the Contractor, his subcontractors or suppliers, causes the damage, then the repairs will be at his own cost.

The Contractor shall be responsible for the construction, maintenance and repair of any temporary works access roads.

The lands and other places outside the Site, which are the property of or under the control of the Employer, shall not be used except with the approval of the Engineer.

The Contractor shall promptly remove any vehicle, wagon, barge or vessel or any other obstruction under his control that the Engineer may require to be moved for any purpose. The Contractor shall remove such obstruction promptly upon receiving such instruction and at his own cost, unless the Engineer shall decide otherwise.

The Contractor shall maintain access for the inspection, operation and maintenance of any of the Employer's assets within the Site or elsewhere.

The Contractor shall not use any portion of the Site for any purpose not connected with the works unless the written permission of the Engineer has been obtained.

Except with the written permission of the Engineer, to be given when necessary for the execution of the works, the Contractor's employees will not be permitted to enter any of the Employer's buildings or lands or sites under the control of other contractors or the Engineer. The Contractor shall warn his employees that any person found within such buildings or sites without authority is liable to be removed from the works in accordance with the Conditions of Contract

1.18.3 Possession of the Site

The Contractor shall restrict his activities to those areas of the Site adjacent to the works being executed and shall avoid any encroachment upon lands outside the areas for which possession has been given. Any trespass or damage or any claim arising from such encroachment shall be the Contractor's sole responsibility and he shall hold the Employer indemnified against all claims arising from such trespass or damage.

1.18.4 Interference with existing works

The Contractor shall not interfere in any way, with any existing works, be it the property of the Employer or of a third party, whether such works has been shown to the Contractor by the Engineer, except where such interference is specifically described as part of the works, either in the Contract or in instructions from the Engineer to take over such works.

1.19 Materials for the works

All materials shall comply with the appropriate Standard Specifications unless otherwise required hereinafter.

The Contractor, shall, before placing any order of materials, manufactured articles or machinery for incorporation in the works, submit for the approval of the Engineer the names of the suppliers from whom he proposes to obtain such materials, manufactured articles or machinery, together with a list of the same, giving the origin, quality, weight, strength, description and other relevant details. No materials, manufactured articles or machinery shall be ordered or obtained from any suppliers not approved in writing by the Engineer.

All materials shall be delivered to the Site a sufficient period of time before they are required for use in the works, to enable the Engineer to take such samples as he may wish for testing and approval.

Notwithstanding the fact that approval has been given to the source of supply, the Engineer may forbid the use of any materials if, upon delivery, they are found to be

defective, or he considers them unsuitable for incorporation in the works. Such rejected materials shall be removed from the site forthwith.

The Contractor may propose alternative materials of equivalent quality to those specified, and subject to the Engineer's approval, such materials may be used in the works.

The Contractor shall have no claim against the Employer in respect of any financial loss which he may suffer as a result of the rejection of any such materials, and he shall also bear the cost of removing them from the Site.

The Engineer shall have the right to inspect materials and plant for the permanent works during the course of manufacture. The Contractor shall arrange for the right of access to manufacturing premises for the Engineer and his staff during normal working hours. The Contractor shall give the Engineer sufficient notice to allow him to observe the testing of any materials for the works at the place of manufacture. The Engineer shall also be given the opportunity to inspect any material or plant in their completed state before packing for transport to the site.

If requested by the Engineer, the Contractor shall provide the Engineer with copies of orders for the supply of goods or materials required for the works.

1.19.1 Alternatives

The Contractor's main Bid shall comply fully with the Specification.

The Contractor is however at liberty to include alternative materials, items of Plant or methods of construction for which he claims advantages to those indicated in the Specification and Drawings, provided the modes of operation and methods of construction are fully described and are at least equal to those shown on the Drawings or Implied in the Specification.

The Contractor shall submit manufacturer's detailed descriptions of alternatives and he shall draw attention to any aspect of each component that does not fully comply with the requirements of this Specification. These detailed descriptions, including any departure from the requirements of the Specification may, after approval by the Engineer, be included among the Contract Documents and each item shall be in accordance with the description of it. Approval of a manufacturer's description shall not include approval of any departure from the requirements of the Specification unless the Engineer in writing specifically approves the departure.

Where materials, Plant or methods of construction differ from those specified, the Contractor shall submit with his Bid drawings showing any amendments of system design necessary to suit the alternative. The Engineer will either approve these drawings or issue others if he approves the components concerned.

The Engineer, however, may not necessarily accept any alternative put forward.

1.19.2 Responsibility for ordering materials and manufactured articles and samples for testing

The responsibility for so ordering and delivering materials and manufactured articles and samples that they may be tested sufficiently far in advance of the work as not to delay it, shall rest upon the Contractor, and he shall not be entitled to any time credit for delay occasioned by his neglect to order sufficiently well in advance or to effect payment of any costs he may incur as a result thereof.

With regard to any item in the Bill of Quantities which is the subject of a P.C. Sum, the Contractor shall notify the Engineer of his requirements as early as possible leaving

ample time for the Engineer to make any necessary arrangements so that no delay occurs in the progress of the work.

1.19.3 Submission of samples

Before incorporating in the finished work any materials or articles which he supplies under the terms of the Contract, the Contractor shall submit to the Engineer's Representative for his approval a sample of each respective material or article, and such samples shall be delivered to and kept at his office for reference. All the respective kinds of materials and articles used in and upon the Works, shall be at least equal in quality to the approved samples. Each and every sample shall be a fair average of the bulk material or of the article which it represents. The Engineer's Representative may decide the method by which each sample to be taken from the bulk material shall be obtained.

1.19.4 Tests of Materials and Manufactured Articles Before Use

Any or all of the materials and manufactured articles supplied by the Contractor for use on any of the Works throughout this Contract shall be subject in advance to tests as may be specified in the relevant Standard Specification as may from time to time be deemed necessary by the Engineer. Samples of all such materials and manufactured articles, together with all the necessary labour, materials, plant and apparatus for sampling and for carrying out of tests on the site on all such materials and manufactured articles shall be supplied by the Contractor at his own expenses. The cost of special tests ordered by the Engineer to be carried out by an independent person at a place other than the site or place of manufacture or fabrication shall be borne by the Contractor.

1.19.5 Rejected materials and defective work

Should any material or manufactured articles be brought on to the site of the Works which are in the judgement of the Engineer do not comply with the Specification , unsound or of inferior quality or in any way unsuited for the work in which it is proposed to employ them, such materials or manufactured articles shall be classified as rejected materials or defective work, and shall be cut out and removed from the works and replaced as directed by the Engineer. The material shall forthwith be removed from the site of the Works, all at the Contractor's expense and in each case as the Engineer shall direct

1.19.6 Quality of materials and workmanship

The materials and workmanship shall be of the best of their respective kinds and shall be to the approval of the Engineer. In the reading of this Specification the words "to the approval of the Engineer" shall be deemed to be included in the description of all materials incorporated in the Works, whether manufactured or natural and in the description of all operations for the due execution of the Works.

1.20 Existing works and services

The Contractor shall acquaint himself with the positions of all existing works and services including water mains, sewers, storm water drains, cables for electricity and lighting poles before any excavation is commenced.

The Contractor will be held responsible for any damage, however caused, in the course of the execution of the works, to such existing works and services. Any damage caused shall be made good at the Contractor's expense.

Such existing works and services, where exposed by the execution of the works, shall be properly shored, hung-up and supported to the satisfaction of the Engineer and of the authority concerned. The Contractor shall exercise special care when refilling trenches or other excavations around such existing services. Stop cock boxes, water meters and the like shall not be covered up.

Poles supporting cables and the like adjacent to the works shall be kept securely in place until the works are completed and shall then be made as safe and permanent as before.

Notwithstanding the foregoing requirements and without lessening the Contractor's responsibility, the Contractor shall inform the Engineer immediately any existing works have been exposed and shall comply with any requirements of the authority concerned.

Only when and as directed by the Engineer shall the position of existing works or services be changed by the Contractor to meet the requirements of the proposed work.

The Contractor shall make adequate provision so that when carrying out his work, no interference, damage or pollution is caused to roads and footpaths, or to any mains, drains, sewers, and the like or other parts of the works.

The Contractor shall not store any plant or materials or spoil heaps over existing water mains, or in such positions that interference with access to the mains, control valves and the like, is created. Approval by the Engineer to the means of protection employed shall not relieve the Contractor of any responsibility in respect of damage occasioned by his operations.

The laying of pipework, ducts, drains and the like shall be arranged so as to cause as little disruption, to traffic or public movement as possible with the smooth operation of existing works.

When breaking out and making good existing structures, the Contractor shall disturb the existing structures as little as possible. All structures shall be made good with materials similar to those used in the existing works, or such materials which are considered by the Engineer to be of similar appearance and suitable in all other respects.

1.20.1 Overhead power lines

Where work is being carried out in the vicinity of overhead power lines, the Contractor shall be responsible for ensuring that all persons working in such areas are aware of the safe working distances in the vicinity of high voltage overhead power lines especially when cranes or other large masses of steel are in the vicinity of the power lines.

The Contractor's attention is drawn to BS 162, which gives safe clearance for various voltages.

The Contractor shall take all necessary precautions to ensure the safety of his employees and all other persons where work is being carried out near overhead power lines.

1.20.2 Excavation across roads and tracks

Before excavating across any public or private road or track, the Contractor shall give the Engineer seven days' notice of his attention to excavate and shall include, in writing, the precautions he proposes to take for the continuance of passage and safety of traffic, and details of the warning signs and lights to be provided and operated. The excavation shall not commence until the written approval of the Engineer has been given.

1.20.3 Liaison with police and other officials

The Contractor shall keep in close contact with the police and other officials in the areas concerned regarding their requirements for the control of workmen, movement of traffic, or other matters and shall provide all assistance and facilities which may be required by such officials in the execution of their duties.

1.20.4 Preservation of trees

No tree shall be removed without prior written permission of the Engineer who will limit the removal of trees to the minimum necessary to accommodate the permanent works.
If trees are removed or damaged by the Contractor or his employees, without approval, then the Contractor shall replace such trees.
Replacement trees shall be not less than two years of age, obtained from a reputable nursery and of a species approved by the Engineer.
The Contractor shall plant, water and ensure that the replacement trees are properly established.

1.20.5 Protection from water

The Contractor shall keep the whole of the works free from water and shall be deemed to have included for all pumping, shoring, temporary drains, sumps and other measures and provisions necessary for such purposes and for clearing away and making good to the satisfaction of the Engineer any damage caused thereby.

1.20.6 Protection against fires

The Contractor is advised that, at all times, it is necessary to guard against fires starting within the Site or in the environs thereof, particularly as the result of the works or from the actions of his employees. The Contractor shall have available, at all times, a trained fire-fighting team provided with adequate fire-fighting equipment and shall deal with all fires on the Site howsoever caused.

1.20.7 Rivers and Drains

The Contractor shall at all times maintain the free flow of rivers and drains and prevent excavated material from the Works from being deposited in them.

1.21 Pollution

The Contractor shall ensure that during the course of his operations no pollution of the atmosphere, rivers, reservoir catchment areas or groundwater is allowed to take place.

1.22 Tips

The Contractor shall be responsible for provision of all tips, at his own expense, for disposal of all spoil or other rubbish collected during the construction of the Works. Any surplus excavated material not required shall also be carted away to these tips. The site of the tips must be approved by the Engineer.

1.23 Watching, fencing and lighting

The Contractor shall employ competent watchmen and guard the works both by day and by night.

Any excavations, material dumps, spoil dumps or other obstructions likely to cause injury to any person or thing shall be suitably fenced off and at night marked by red warning lights.

Fences shall consist of at least three 15 mm diameter hemp ropes or 4mm diameter wires, or more if required, stretched tightly between poles, and standards securely planted in solid ground, well clear of the excavation. The poles and standards shall not be more than 15 metres apart, and where circumstances require, they shall be placed closer. Ropes or wires shall be stretched tight approximately 0.4 m, 0.8 m and 1.2 m above the ground. The Engineer may accept banks of spoil instead of fencing, if of suitable height and form.

Fences and spoil banks shall be clearly marked at the ends, all corners, and along the length at intervals of not more than fifteen metres by means of white lime-washed boards, discs, stones or oil drums during the daytime and by red lamps burning at night. Markers shall be freshly lime-washed at regular intervals to ensure that they are white and clean.

If a road is closed, or partly closed to traffic, temporary traffic signs and barricades shall be erected by the Contractor to the satisfaction of the Engineer and the police, or other relevant authority, to give proper warning to traffic and the public. Lettering on road signs shall be black on a yellow background and shall incorporate reflective material. The signs shall be adequately illuminated at night.

1.24 Water and power for use on the works

The Contractor shall be solely responsible for the location, procurement and maintenance of a water supply adequate in quality and quantity to meet his obligations under the Contract.

The Contractor shall be solely responsible for the location and continuity of the supply of water for use on the works. Supplies may be derived from boreholes, rivers and streams, but shall in all cases be to the Engineer's approval. The abstraction of water from any sources shall not interfere with any permanent water supply. The Contractor shall be solely responsible for the transporting of water from its source to the point at which it is required for construction purposes, and in such quantities and quality as to enable the works to proceed without hindrance due to the shortage of adequate water supplies.

The Contractor shall take care to avoid unnecessary use of water and to prevent any water running to waste.

The Contractor shall make his own arrangements for power supplies and shall be solely responsible for the location, procurement and maintenance of a power supply, adequate to meet his obligations under the Contract.

1.25 Telephone and communications

The Contractor shall obtain suitable means of communications during the course of the Contract. The use of radio communications may be permitted but the Contractor shall be responsible for obtaining all the necessary permits and licences.

1.26 Sanitation

The Contractor shall provide adequate sanitation and refuse collection and disposal facilities complying with state laws and local by-laws for all houses offices workshops, and the like, erected on the site, all to the satisfaction of the Engineer.
The toilet facilities provided at the site by the Contractor shall be made available, free of charge, to the employees of the Contractor and any of his subcontractors.
The Contractor shall warn his employees and subcontractors that any employee found fouling the site shall be removed from the site immediately in accordance with the Conditions of Contract.

1.27 First aid and medical services

The Contractor shall provide and maintain all equipment necessary to render first aid in case of accidents, snakebites or other emergencies. This equipment shall be kept in readiness at the sites of the works, at camps and wherever the Contractor's staff may regularly live and work. The Contractor shall ensure that there are persons available at all such places with knowledge of simple first aid procedures and able to administer snakebite treatment.

1.26 Health checks

The Employer may arrange for the taking of swabs, urine and stool samples from all persons who will be working in and around the works, to ensure that all such persons are free from contagious diseases.
The Employer will pay all medical costs incurred in the taking and analyses of these samples. The Contractor shall make his employees available during normal working hours for undergoing the above-mentioned health checks. Reasonable notice will be given.
The Contractor shall keep records in respect of all his employees, showing the dates on which health checks have been and will be carried out.
Every employee whom the Contractor intends to engage on the works shall, in addition to being available for the above tests, successfully undertake a test for typhoid and paratyphoid at an approved hospital or medical centre. The medical certificate for each employee shall be submitted to the Engineer before the employee shall be allowed on Site.

1.28 Health and safety

1.28.1 General

The Contractor shall use his best endeavour to ensure, so far as is reasonably practicable and to the satisfaction of the Engineer, the health, safety and welfare at work of his employees, including those of his Subcontractors, and of all other persons on the Site. His responsibilities shall include:

(i) Provision and maintenance of safe and properly illuminated Contractor's Equipment;
(ii) Establishment of safe and well-illuminated systems of working;
(iii) Provision of protective clothing and equipment;
(iv) Establishment of first aid stations, staffed and equipped to provide information, instruction, training and supervision on all aspects of safety and health on site;
(v) Appointing as Safety Officer one of his senior staff who shall have specific knowledge of safety regulations and have had experience of safety precautions on similar works and who shall advise the Contractor on all aspects of safety and

health on Site; Provision and maintenance of safe access to all work areas on the Site;

(vi) Provision of adequate sanitary facilities and maintenance of these in a clean and hygienic state for use by all persons employed by the Employer, Engineer, Contractor or other contractors on the Site;

(vii) Measures to control flies, mosquitoes and pests in both working and recreational areas including chemical spraying, if necessary, in compliance with the rules and regulations of the Employer;

(viii) Reporting details of any accident to the Site Safety Officer as soon as possible after its occurrence;

(ix) Reasonable prevention of non-site personnel from entering the work areas.

1.28.2 Safety equipment and training

The Contractor shall provide:

- All necessary breathing apparatus, safety harnesses and any other equipment required to ensure safe working of all his personnel on Site;
- Test certificates for all safety equipment;
- Proof that all relevant personnel have received appropriate training.

1.28.3 Health and safety plan

The Contractor is required to produce a health and safety plan covering the hazards that may apply during the Contract, the rules and standards to be used in assessing risk and in undertaking work and the methods that he will employ to ensure compliance with his plan.

The Health and Safety Plan shall include details of the following:

- Details of all potential risks and the proposals for dealing with such hazards;
- Controls to regulate risks that occur during all construction, testing and commissioning activities;
- Measures to avoid health risk in connection with the use, handling, storage and transportation of hazardous and harmful substances;
- Safety equipment and training proposals in respect of equipment referred to above.

1.29 Sign boards

Before the erection of any signboards or posters by the Contractor, the Contractor shall obtain the approval of the Employer and the Engineer to the size, location and wording of such sign boards or posters.

1.30 Building regulations

All buildings erected by the Contractor upon the Site and campsite or sites and the layout of the buildings shall comply with the Laws of the Land and all local by-laws as far as they are applicable.

1.31 Progress photographs

Photographs showing the progress of the works shall be taken by a competent photographer every month from positions to be selected by the Engineer.

Special photographs showing particular features of the works or matters of interest concerning the works or their surroundings shall also be taken from time to time as and when required by the Engineer.

Photographs shall not be less than 120 mm x 90 mm and shall be inscribed with the date when taken and a brief description or title.
All negatives shall be numbered; retained on the site and on completion of the works the negatives shall become the property of the Employer.
An item is included in the Bill of Quantities for the cost of such photographs

1.32 Contractor's tracked equipment

The Contractor's tracked equipment may not be run on any public or private road without the written permission of the owner or authority concerned.

1.33 Progress meetings

Throughout the project period, progress meetings will be held to discuss the progress of the work, schedule for the ensuing month, methods of construction, procurement, transportation, labours, etc. These meetings can be called at any time intervals at the request of the Contractor or as directed by the Project Manager.
The Contractor shall be obliged to attend all site meetings at the appointed time.

1.34 Pollution

During the execution of the works, the Contractor shall ensure that no pollution of existing watercourses is allowed to take place because of his activities. The Contractor shall take all reasonable steps to protect the environment on and off the site and to avoid damage or nuisance to persons or to property of the republic or others resulting from pollution, noise or other causes arising as a consequence of his methods of operation.

1.35 Site clearance

On completion of the works, the Contractor shall clear the site and remove all temporary buildings, equipment and debris. The Contractor shall level off and grade all areas used for haul roads and all building, store and workshop areas. The whole of the site shall be left in a clean and tidy condition.

1.36 Protection of works

The Contractor shall carefully protect from injury by weather all work and materials which may be affected thereby.

1.37 Damage to land

Except where specified for the proper execution of the Works, the Contractor shall not interfere with any fence, hedge, tree, land or crops within, upon or forming the boundary of the site or elsewhere. In the event of such interference, the Contractor shall make good to the satisfaction of the owner and the Engineer and shall pay to the owner such damages as the Engineer may determine.

1.38 Privately owned or public services

If any privately owned or public services passing through the site will be affected by the Works, the Contractor shall provide at his own expense a satisfactory alternative service in full working order to the satisfaction of the owner of the services and the Engineer, before the cutting of the existing service. Any damage to private or public services shall be made good by the Contractor at his cost.

In case the remedial work is not executed promptly by the Contractor, the Engineer may make alternative arrangements for the execution of the work and debit the costs to the Contractor.

1.39 Construction Programme

The Contractor shall submit to the Engineer for approval, a revision of the Construction Programme attached in four (4) copies and after approval to the Employer in two (2) copies in the following manner:

(1) Within seven (7) days after receiving the Letter of Acceptance, the Contractor shall submit to the Engineer for approval, a detailed Programme based on the key date stated hereinafter or other dates which are given in the Letter of Acceptance in the form of a Critical Path Method (hereinafter referred to as CPM Network) showing the order of procedure in which he proposes to carry out the Works including design, manufacture, delivery to the site, transport, storage, survey, construction, commissioning and maintenance. This Programme shall indicate clearly all activities and its duration along with the earliest and the latest event, times and the first and last dates of the submission of the Drawings and each date of shop inspection by the Engineer for the section or portion of the Works.

The Programme so prepared shall be rearranged in the form of a Time Bar-chart Schedule of which size shall be 841mm x 594mm (A-1 size). This Time Bar-chart Schedule shall be submitted to the Engineer together with the CPM Network.

(2) The CPM Network shall be in accordance with commonly accepted practices and shall show graphically the chain of activities / sub-activities and their sequential relationship with each other from the start of construction to the completion of the Contract. The Time Bar-chart Schedule shown in weeks shall list all main activities and its applicable sub-activities.

(3) In preparing the CPM Network and the Time Bar-chart Schedule the Contractor shall make do allowances for possible delays. Under no circumstances shall the CPM Network or the Time Bar-chart Schedule show a completion in excess of the "Time for Completion" stated in the Form of Tender.

(4) The Programme once approved by the Engineer shall thereafter be referred to as the Contractual Programme. The Engineer's approval of such Programme shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

1.40 Inspection by engineer during defects liability period

The Engineer will give the Contractor due notice of his intention to carry out inspection during the Defects Liability Period and the Contractor shall upon receipt of such notice arrange for a responsible representative to be present at the times and dates named by the Engineer. This representative shall render all necessary assistance and take notice of all matters and things to which his attention is directed by the Engineer.

2. EXCAVATION AND FILLING

2.1 Site clearance

The Contractor shall demolish, break up and remove buildings, walls, gates, fences, advertisements and other structures and obstructions, grub up and remove trees, hedges, bushes and shrubs and clear the site of the works at such time and to the extent required by the Engineer but not otherwise, subject to the provisions of Clause 27 of the Conditions of Contract: the materials so obtained shall so far as suitable be reserved and stacked for further use; all rubbish and materials for use shall be destroyed or removed from the site, as directed by the Engineer.

Where topsoil has to be excavated this shall be removed and stacked on site. After completion of construction, it shall be spread over the disturbed ground, any surplus being disposed of as directed by the Engineer.

Underground structures and chambers where required to be demolished, shall be demolished to depths shown on drawings or as directed. They shall be properly cleaned out and backfilled and compacted with suitable material to the direction and approval of the Engineer.

2.1.1 Vegetation

No allowance will be made for the cutting and removal of crops, grass, weeds and similar vegetation. The cost of all such work will be held to be included in the rates entered in the Bill of Quantities.

2.1.2 Bushes and Small Trees

All bushes and small trees, the main stem of which is less than 500mm girth at 1 metre above ground level shall be uprooted (unless otherwise directed by the Engineer) and burnt or otherwise disposed of as directed by the Engineer.

2.1.3 Grubbing-up roots

Stumps and tree roots shall, unless otherwise directed, be grubbed up, blasted, burnt or removed and disposed of in approved dumps to be provided by the Contractor. Where directed by the Engineer, the holes resulting from grubbing up shall be filled with approved materials, which shall be deposited and compacted in layers not exceeding 225mm loose depth, to the same dry density as that of the adjoining soil. For the purpose of measurement, tree roots shall be classified according to the mean diameter of the stump measured across the cut.

2.1.4 Areas occupied by Permanent Works

The Contractor shall clear all borrow areas and other areas where it is intended to use the material below for construction purposes by removing all trees, roots, stumps, topsoil, vegetable matter, buildings and other debris which is unsuitable for fill. The Contractor shall deal similarly with all areas under permanent and temporary embankments, in other foundation areas, under permanent roads where organic material is present, and where it is intended to place fill directly on the existing ground surface.

2.1.5 Areas Occupied by Temporary Works

The bush clearing for the contractor's camps, offices, stores, working areas and for his access roads and his own borrow areas shall be at the Contractor's expense. Clearance for temporary works shall be kept to a minimum and be subject to the approval of the Engineer.

2.1.6 Structures

Structures shall not be demolished unless specified or directed. Methods of demolition shall be approved.

2.1.7 Spoil Materials

Material shall not be left lying around just outside the periphery of the area to be cleared but shall be properly disposed of or removed completely to the approval of the Engineer.

The Contractor shall dispose of all trees, bushes and other vegetable matter by stockpiling in piles or windrows (longitudinal heaps) and burning. Secondary burning shall be carried out as necessary such that all material is reduced to a white ash. All burning shall be kept under full control. Unburnt tree trunks shall be either restock piled and included in further burning operations or cut up and removed from the area.

2.1.8 2.1.8 Programming

The programming of all clearing works shall be subject to the approval of the Engineer.

2.2 General excavation clauses

2.2.1 Advance Notification of Proposed Methods

The Contractor shall submit for the consent of the Engineer detailed proposals for methods, dewatering and safety arrangements in respect of each major or critical section of excavation, including drilling and blasting where appropriate. Except as may be otherwise agreed, the proposals shall be presented at least 1 weeks before the intended start date and the Engineer shall comment on the proposals within 4 days. Only after the receipt and revision of these proposals as may be requested, and with the written consent of the Engineer, shall the Contractor commence the excavation work to which the proposals refer.

The Engineer shall not unreasonably withhold consent and will request revisions of proposals only if he considers that an acceptable end result would otherwise be unlikely. The Contractor shall not subsequently vary the agreed procedure, except in detail, without having obtained the written consent of the Engineer to the change.

No consent as described above shall relieve the Contractor of his responsibility for carrying out his operations in a workmanlike manner and as safely as is reasonably possible to the lines and levels shown on the Drawings or as instructed by the Engineer.

2.3 Dewatering of Excavations

The Contractor shall maintain all excavations free from water, irrespective of its source, to the extent necessary for the execution of the Works or in the interests of safety, and to the satisfaction of the Engineer. He shall provide, install, operate and maintain all necessary appliances and Plant for this purpose.

The Contractor shall take all necessary precautions at points of discharge of water to avoid flooding or damage to the Works, adjoining works or property and to avoid pollution of watercourses.
The dewatering of excavations immediately prior to concreting shall not be commenced until at least one standby pump is on hand.

2.3.1 Work

Any damage resulting from the Contractor's operations during excavation, including damage to foundations and excavated surfaces shall be repaired at the expense of the Contractor and to the satisfaction of the Engineer.

2.3.2 Safety of Excavations and Persons

The Contractor shall take full responsibility for the stability and safety of all excavation works and methods of construction including temporary support of excavated surfaces, diversion of water, pumping etc. He shall assume full responsibility for the safety and prevention of injury to personnel and for damage. His safety provisions shall comply with relevant local regulations and the requirements of Section 1.8.
The Contractor shall provide and install handrails, toeboards and all necessary temporary supporting works such as timbering, shoring, anchorages and the like wherever such support is required. All support arrangements must be to the approval of the Engineer, who may order such support to be strengthened or altered if it is considered necessary in the interests of the work or to safeguard against accidents to workmen.

If the Contractor wishes to batter and/or cut back the face of an excavation in order to eliminate or reduce the quantity of timbering and shoring required, he shall obtain permission from the Engineer. Both the slope and the extent to which such battering is to be carried out must be agreed with the Engineer before excavation is commenced.
Timbering and shoring shall be so designed and constructed that, if necessary, it can be inserted as excavations proceed and safely withdrawn as backfilling is raised. Waling and struts shall be suitably positioned to permit pipes and other materials to be installed in the excavations. No temporary supports shall remain in excavations after backfilling unless approved by the Engineer.
If slips of material occur in any part of the excavations during the execution of the Works or during the Defects Liability Period, the necessary remedial works shall be executed to the approval of the Engineer. Such remedial work shall be at the Contractor's expense in cases where the Engineer considers that the Contractor has not exercised reasonable preventive measures.

2.3.3 Inspection and Surveys by the Engineer

The Engineer shall have the right to gain access to any area of excavation giving adequate notice. The Contractor shall provide whatever assistance and incidental materials may be required. This work will be arranged so as not unduly to disrupt the Contractor's normal working arrangements and he shall allow for it in his programme.

2.3.4 Classification of Excavated Material

Excavation shall be classified for payment purposes only as follows:

(a) Class 1:

All soil overburden, weathered and shattered rock, or cemented sand in river terrace areas and other material which can be removed by hand, by single shank ripping and bull dozing with a track mounted tractor at least equivalent to a modern Caterpillar D6 in weight and horsepower of 165Hp or, in confined areas, by a mechanical excavator equivalent to a modern Caterpillar 446B of flywheel horsepower of 102Hp (or gross horsepower of 110Hp) fitted with an extreme service trenching bucket. When used for classifying materials the condition of the equipment should be as new

(b) Class 2:

Rock and artificial hard materials which cannot be removed effectively by the methods described in (a) above and which normally require recognised rock excavation methods such as drilling and blasting or use of hydraulic breakers.

In the event of a dispute as to the classification of a material, the decision of the Engineer shall be final.

The Engineer shall be empowered to require rock to be excavated without explosives and payment will be made accordingly.

2.3.5 Limits of Excavation

General

The surfaces exposed by open cut excavation against which concrete is to be placed shall be excavated to the lines shown on Drawings or as required by the Engineer. No material shall remain within the outline of structural concrete. Elsewhere in open cut, the excavation shall be to the lines and levels shown on the Drawings or as required by the Engineer except that local points of undisturbed hard rock may be permitted to extend within the required lines of excavation where approved by the Engineer.

Revision of Limits

During the progress of the work, the Engineer may find it necessary or desirable to revise the required lines and levels of any part of the excavations because of the conditions disclosed by the excavations or for any other reason. When the Contractor is advised of such revision before the excavation of such part has been commenced to the lines and levels shown on the Drawings, the revised excavation will be paid for at the billed rate for the main excavation. If, however, such revision requires additional excavation to be made after the excavation of such part has already been carried out to a point where the normal procedure for the main excavation cannot reasonably be used, the additional work shall be carried out as specified and will be paid for under the contractual provisions for variations. This will include removal of rock and filling of resultant voids which, in the opinion of the Engineer, could not reasonably have been anticipated and are beyond the control of the Contractor.

Excavation beyond Limits

The Contractor shall not deliberately excavate beyond the lines and levels shown on the Drawings or designated by the Engineer (as above or otherwise) without prior written approval. Any deliberate excavation beyond the required lines and levels which is performed by the Contractor for any purpose (such as for working space) shall be at the expense of the Contractor. If such excavation should, in the opinion of the Engineer, require to be backfilled, such backfilling shall be done at the Contractor's expense to the satisfaction of the Engineer with concrete or material similar to the fill to be placed against the excavated surface. Beneath load bearing structures, foundations and other reinforced concrete work, the filling to any over excavation shall be of the same quality

concrete as that required for the associated concrete structure unless the Engineer permits leaner concrete.

Where it is intended that concrete be cast against the side of excavated material the Contractor may alternatively propose to the Engineer to over excavate, back shutter and backfill, but the Engineer will be under no obligation to accept the proposal and, subject to the conditions listed in the notes on measurement, no extra payment will be made if the alternative proposal is accepted.

2.3.6 Sources of Fill Materials

The Contractor shall obtain the necessary general fill materials for construction of the works from excavations required to be undertaken for the permanent works.
Other fill materials such as sand, graded aggregate and rockfill for use as fill materials shall be obtained by the Contractor from sources to be approved by the Engineer. The Contractor will be entirely responsible for ensuring that the materials supplied meet the requirements of the Specification including for any necessary crushing, blending or other preparation.
Acceptance by the Engineer of the source of any material in no way will be deemed to imply approval by the Engineer of the material to be supplied, nor shall approval of a potential borrow area be construed as constituting approval of all materials contained therein.

2.3.7 Use of Material from Excavations for the Works

General

Depending on its nature and quality, excavated material will either be:

- Re used as fill or backfill;
- taken to spoil.

The Contractor shall select materials as required and use his skills to avoid unnecessary waste of potentially usable materials.

Re-Use of Material

Where the Contractor has been informed that the intention is that excavated material is to be re used elsewhere in the Works, the Contractor shall ensure that his excavation techniques result in material suitable for the particular re use requirement which is described.
In order to achieve particular materials, the Contractor shall be prepared to sort materials into different stockpiles, which he must maintain in an uncontaminated condition. Any contaminated material shall be abandoned and replaced at the Contractor's expense. The contractor may be required to cart the excess contaminated material to spoil or dispose them in-situ as directed by the Engineer. No extra costs will be paid to the contractor for complying with such instructions. In executing the instructions issued by the Engineer, the contractor will be required to give effect to the environmental concerns specified in section 1.9 hereof.
In all such cases it will be to the Contractor's advantage to phase as far as possible the excavation work to suit the construction in which the excavated material is to be re used, particularly as no additional payment for double handling of materials will be made.

2.3.8 Requirements Specific to Excavations for Particular Parts of the Works

Trenches, Manholes and Confined Foundations

Confined and narrow excavations, such as for trenches and manholes, shall be excavated with particular care and attention to adequacy of temporary strutting because trench collapses are one of the commonest causes of death and injury on construction sites. The dangers inherent in inadequate supervision of such work, particularly in water bearing ground or damp conditions, cannot be over emphasised. Continuous dewatering may be necessary in water bearing ground.

Excavated material shall be cast or moved to a position sufficiently far away from the edge of the trench that instability of the trench wall (supported or otherwise) will not be called into question.
Excavated material which will clearly be unsuitable as backfill shall be removed to spoil as soon as possible after being excavated.
The widths of trenches for pipes shall be of the minimum required or as shown on the Drawings. Trenches shall not be so narrow that the pipe cannot be properly installed and jointed. Neither shall they be of excessive width or with battered sides because this will increase the loading on an unprotected pipe. At pipe joint locations the trench shall be widened and deepened to leave the joints unsupported so that they can be properly made and inspected. In Class 2 material an extra 150 mm over the depth for Class 1 material shall be excavated and replaced by pipe bedding material.
Supports shall be left in permanently when so directed when they are removed, the removal shall be done progressively as backfilling proceeds and in stages so that no voids are left.
Excavations at or near the toes of cuttings or embankment slopes shall be carried out in such a manner that there is no excavation into the slopes. In such trenches the pipe run shall be completed and backfilled at the end of each day's work unless otherwise agreed with the Engineer.

Trenchless Excavation

Excavation for road crossings shall be trenchless using such methods as tunnelling, micro-tunnelling (MTM), directional boring, pipe ramming (PR), pipe jacking (PJ), moling, horizontal auger boring (HAB) and other methods as may approved by the Engineer.

Where trenchless excavation is to be applied, the contractor shall provide a method statement for approval of the Engineer, describing (including diagrams) the excavation process and giving full description of the proposed equipment. The Contractor shall seek approval of the relevant authorities to carry out such excavation.

Structures

The Contractor shall excavate such that concrete and other structures may be formed to the lines and levels shown on the Drawings or as instructed by the Engineer. He shall increase the dimensions above the minima required in the interests of safety if so directed by the Engineer. In the course of the excavation work, the surrounding material shall be preserved in the soundest possible condition.

Excavation for foundations in Class 1 material shall be made to approximately 0.5 m above the levels shown on the Drawings. Final trimming shall be delayed until shortly before foundation preparation is due to commence.

During the course of blasting operations where, in the opinion of the Engineer, action is necessary to avoid damage to adjoining material or to adjacent structures, the Engineer may instruct the Contractor to reduce the explosive charges or to use other methods

such as pre-splitting or cushion blasting or to cease using explosives altogether and to continue by other means such as use of hydraulic breakers or line drilling.

Excavated surfaces which will remain permanently exposed shall be finished off in a neat and workmanlike manner and graded to provide adequate drainage. Rocky material liable to become detached from such surfaces shall either be removed (and holes backfilled where practicable) or anchored.

Excavated surfaces on or against which concrete structures will be cast shall be trimmed so that there are no projections within the permissible limits and cleaned to remove loose, soft or foreign materials by hand, air and water jets or other effective means. Unless shown otherwise on the Drawings or directed by the Engineer, the Contractor shall cast all in situ concrete structures against the excavated side surface in Class 2 material. Thus, when excavating in Class 2 material, excavation lines shall be kept as close as possible to the actual structural requirements.

Where the Contractor over excavates sides of excavations by an additional width exceeding 500 mm, the Engineer shall be empowered to direct the Contractor to use formwork at his own expense to achieve the final surfaces of in situ concrete structures.

2.3.9 Disposal of Excavated Material

Material which has to be excavated in order to execute the Works but is unsuitable for construction purposes or which is surplus to requirements as fill, shall be kept separate from other materials and not allowed to cause contamination of material required for use in the Works. Such unwanted material shall be disposed of by spreading the material in layers in designated spoil areas as directed by the Engineer. The material shall be compacted to the maximum practicable extent by routing the haulage traffic over the area. Permanent spoil areas visible after completion shall be shaped to follow existing contours such that the tips blend in with the local topography. Such disposal areas shall be kept neat and tidy. Surfaces shall be finished and graded to the extent necessary to provide surface drainage and grassed to prevent future erosion of the materials.

2.3.10 Dust and Noise Prevention

The Contractor shall make masks and ear mufflers available to those personnel engaged on operating inherently noisy equipment and other work entailing long-term exposure to dust and noise and the consequent danger of contracting ill effects there from.

The Engineer shall be empowered to ask for excessively noisy equipment to be removed and replaced.

2.3.11 Procedure on Completion of Excavation

Upon substantial completion of excavation, the excavated surface shall be cleared of spoil sufficiently to allow inspection by the Engineer. Final clearing and surface preparation procedures shall not commence until the Engineer has approved the excavated level. Neither shall any excavated surface for the Permanent Works be covered until the Contractor has obtained the approval of the Engineer. The Contractor shall at his own expense uncover any excavation which has been covered without such approval.

Where the material replaced in an excavation is other than the material removed, supports shall be removed before or during filling and in such a way that the material from the walls of the excavation does not contaminate the replacement material.

Excavated surfaces which are to have fill material or concrete placed upon them shall be prepared as specified elsewhere.

2.3.12 Site Investigation

Information regarding the geology of the soil in the region is not provided to the Contractor, the Contractor will be deemed to have made his own enquiries and investigation at the time of tender.

2.3.13 Backfilling of Excavations

Scope

These clauses cover the backfilling of excavations except for

Pipe trenches and the like, for which the requirements are given in the Pipework Section.

Materials

Fill material used for backfilling excavations shall be approved Class 1 material free from large clods, large rocks, rubbish and other undesirable constituents. Where free draining material is shown on the Drawings, all layers thereof shall be of consistent quality.

Backfill material shall normally be selected by the Contractor from excavated material at the Site which he has set aside for this purpose. When suitable backfill material cannot be obtained in this manner, it shall be obtained by the Contractor from another borrow source and brought to the Site. Both the source and the type of material to be used will be subject to approval by the Engineer.

Procedure

Unless otherwise agreed, backfilling shall be carried out in layers not exceeding 150 mm after compaction. Each layer shall be watered to the approximate optimum moisture content and thoroughly compacted uniformly over the full area of each layer to the density of the surrounding ground. Unless otherwise instructed, vibrating plate or similar compaction equipment shall be used in confined areas. Where appropriate the final layer of backfill shall be neatly finished to accord with the surrounding ground levels and any settlement which occurs shall be made good by re-compacting and the addition of further compacted backfill.

2.3.14 Compaction of Fill

All materials used in fill shall be compacted to specification by plant approved by the Engineer for that purpose. Maximum compacted thickness of such layers shall not be more than 200mm.

Work on the compaction of plastic materials for fill shall proceed as soon as practicable after excavation and shall be carried out only when the moisture content is not greater than 2 per cent above the plastic limit for that material. Where the moisture content of plastic material as excavated is higher than this value the material shall be run to spoil and an equal volume of material suitable for filling shall be replaced, unless the Contractor prefers, at his own expense, to wait until the material has dried sufficiently for acceptance again as suitable material.

2.3.15 Stone Revetments (Stone Pitching)

Where shown on the drawings, the slopes of embankments, rivers, streams, watercourses and other surfaces shall be protected against water or other action by hand-set stone facing set on end. The larger stones shall be roughly dressed on the bed and face, and roughly square to the full depth of the joints. No rounded boulder shall be used, or stones less than 225mm in depth of 0.05 cubic metre in volume. The stones shall be laid to break bond and shall be well bedded on to a 75mm layer of gravel or fine rubble rammed to a uniform surface and the whole work finished to the satisfaction of the Engineer. Where required, a trench shall be excavated at the bottom of the slope to such a depth as will ensure a safe foundation for the revetment.

2.3.16 Trenches of greater width and depth than necessary

The Contractor shall not be entitled to payment in respect of excavation to any greater extent, whether horizontally or vertically, than is necessary to receive any structure for which the excavation is intended, except where a separate item is provided for additional excavation for working space, timbering, or other temporary work. Excavation to a greater depth or width than directed shall be made good with suitable materials to the satisfaction of the Engineer and at the Contractor's cost.

2.3.17 Supports for Trenches

The sides of trenches shall where necessary be adequately supported to the satisfaction of the Engineer by timber or other approved means.

2.3.18 Provision of spoil heaps

The Contractor shall provide spoil heaps at his own expense for the disposal of surplus material and all rubbish collected when clearing the site and during the construction of the works. The sites for these shall be approved by the Engineer.

2.3.19 Water in excavations

All excavations shall be kept free from water, from whatever source, at all times during construction of works until in the opinion of the Engineer, any concrete or other works therein are sufficiently set. The Contractor's rates are deemed to cover compliance with this requirement.

The Contractor shall construct any sumps or temporary drains that the Engineer may deem necessary and shall be responsible for the removal and disposal of all water entering the excavations from whatever source and shall deal with and dispose of such water in a manner approved by the Engineer so as to ensure that excavations are kept dry.

The Contractor shall provide all plant, labour and materials required for such work and all costs incurred shall be deemed to be included in his rates for excavation.

3. CONCRETE

3.1 Definitions

Structural concrete is any class of concrete which is used in reinforced, prestressed or unreinforced concrete construction, which is subject to stress.

Non-structural concrete is composed of materials complying with the Specification but for which no strength requirements are specified, and which is used only for filling voids, blinding foundations and similar purposes where it is not subjected to significant stress.

A formed surface is a face which has been cast against formwork.

An unformed surface is a horizontal or nearly horizontal surface produced by screeding or trowelling to the level and finish required.

A pour refers to the operation of placing concrete into any mould, bay or formwork, etc. and also to the volume which has to be filled. Pours in vertical succession are referred to as lifts.

3.2 Materials

3.2.1 Cement

Cement, unless otherwise specified, shall be Portland cement of the Blue Triangle brand, or Bamburi Portland Cement brand. Any other brand must be approved by the Engineer and shall comply with the requirements of B.S. 12 with the exceptions that it may contain reactive volcanic ash (of not more than 10% of total weight) and the quantity of insoluble residue permitted in B.S. 12 may be exceeded. A manufacturer's Certificate of Test in accordance with B.S. shall be supplied for each consignment delivered to site.

Should the Contractor require using cement of the rapid hardening variety, he shall obtain the approval of the Engineer and also obtain any instructions regarding the modifications to the preambles caused thereby. Any additional cost that may be caused by the use of the rapid hardening cement shall be at the Contractor's expense.

Cement may be delivered to site either in bags or in bulk. If delivered in bags, each bag shall be properly sealed and marked with the manufacturer's name and on the site is to be stored in a weather-proof shed of adequate dimensions with a raised floor. Each consignment shall be kept separate and marked so that it may be used in the sequence in which it was received. Any bag found to contain cement which has set or partly set shall be completely discarded and not used in the Works. Bags shall not be stored more than 1500 mm in height.

If delivered in bulk the cement shall be stored in a weather-proof silo either provided by the cement supplier or by the Contractor, but in either case the silo shall be to the approval of the Engineer.

3.2.2 Aggregates

The aggregates shall conform to the requirements of B.S. 882 and the sources and all types of all aggregates are to be approved in all respects by the Engineer before work commences.

The grading of aggregates shall be one within the limits set out in B.S. 882 and as later specified and the grading, once approved, shall be adhered to throughout the Works and not varied without the approval of the Engineer. Fine aggregate shall be clean, coarse, siliceous sand of good, sharp, hard quality and shall be free from lumps of stone, earth, loam, dust, salt, organic matter and any other deleterious substances. It shall be graded within the limits set out in zone 1 or 2 of B.S. 882.

Coarse aggregate shall be good, hard, clean approved black trap or similar stone, free from dust, decomposed stone, clay, earthy matter, foreign substances or friable thin elongated or laminated pieces. It shall be graded within the limits of Table 1 of B.S. 882 for its respective nominal size.

If in the opinion of the Engineer the aggregate meets the above requirements but is dirty or adulterated in any manner it shall be screened and/or washed with clean water if he so directs at the Contractor's expense.

Aggregates shall be delivered to the site in their prescribed sizes or grading and shall be stockpiled on paved areas or boarded platforms in separate units to avoid intermixing.

3.2.3 Fine aggregate

Fine aggregate shall be sand free from impurities and complying with British Standard No. 882. Grading zone 2 of Table 2.

3.2.4 Coarse aggregate

Coarse aggregate shall be hard crushed rock free from impurities and complying with British Standard No. 882 "graded aggregate" 20 mm to 5 mm nominal size as Table 1.

3.2.5 Water

Water for concrete shall be free from impurities, complying with BS 3148

3.2.6 Hardcore

Hardcore for filling under floors shall be good, hard stone ballast or quarry waste, to the approval of the Engineer, broken to pass through not greater than a 150 mm ring or to be 75% of the finished thickness of the layers being compacted, whichever is the lesser. Hardcore shall be free from all weeds, roots, vegetable soil, clay, black cotton soil or other unstable materials.

It shall be graded with smaller stones and fine materials to give a dense compact mass after consolidation. Sufficient fine material shall be added to each layer to give gradation of material as necessary to obtain a solid compact mass after rolling. Hardcore filling is to be laid in layers each of a consolidated thickness not exceeding 250 mm. Each layer shall be compacted by at least 8 passes of a 10-tonne smooth-wheeled roller or a 2-tonne vibrating roller until all movement ceases. Sufficient water is to be added to obtain maximum compaction to the Engineer's approval. To each layer a 25 mm thick layer of sand complying with the specification of fine aggregate for concrete shall be spread over the surface and forced into the hardcore by the use of a vibrating roller weighing not less than 2 tones. This operation should be carried out

when the materials are dry and repeated whilst the sand is well watered. Should all the sand be absorbed the Engineer may require a further layer to be applied and the process repeated.

The top surface of the hardcore shall be levelled or graded to fall as required, and shall then be blinded with a layer of similar material broken to 25 mm gauge and finished with a 10-tonne smooth-wheeled roller. The surface so obtained shall be to the Engineer's approval.

3.2.7 Compacted hardcore

The sub-grade shall be compacted by a smooth-wheeled roller of 8 to 10 tonnes weight or the vibrating roller of minimum 1300 Kg., or other approved plant. The number of coverage shall be at least 10 and there shall be a 50% overlap of successive coverage. If so instructed by the Engineer, water shall be added during compaction to obtain optimum water content. Filling shall be compacted as above but in maximum 200 mm deep layers.

3.2.8 Sand

The sand shall be as described for fine aggregate but that for plastering shall be light in colour and well graded to a suitable fineness in accordance with the nature of work in order to obtain the finish directed.

3.3 The design of concrete mixes

The classes of structural concrete to be used in the works shall be those shown on the Drawings and designated in Table 4.1, in which the class designation includes two figures. The first figure is the nominal strength at 28 days expressed in N/mm^2 and the second figure is the maximum nominal size of aggregate in the mix expressed in millimetres.

Table 4.1 - CONCRETE CLASSES AND STRENGTHS

Class of Concrete	Nominal Strength N/mm^2	Maximum Nominal Size of Aggregate mm	Maximum Water / Cement Ratio		Trial Mixes Target Mean Strength (Clause 401 c) N/mm^2	Early Works Test Cubes (Clause 401 d)	
			A	B		Any one Cube N/mm^2	Average of any Group of 4 Cubes N/mm^2
10/75	10	75	0.60	0.55	13.5	8.5	13.3
15/75	15	75	0.60	0.50	21.5	12.8	20.0
15/40	15	40	0.60	0.50	21.5	12.8	20.0
15/20	15	20	0.57	0.50	21.5	12.8	20.0
20/40	20	40	0.55	0.48	31.5	17.0	27.5
20/20	20	20	0.53	0.48	31.5	17.0	27.5

Class of Concrete	Nominal Strength N/mm^2	Maximum Nominal Size of Aggregate mm	Maximum Water / Cement Ratio		Trial Mixes Target Mean Strength (Clause 401 c) N/mm^2	Early Works Test Cubes (Clause 401 d)	
			A	B		Any one Cube N/mm^2	Average of any Group of 4 Cubes N/mm^2
20/10	20	10	0.50	0.48	31.5	17.0	27.5
25/40	25	40	0.52	0.46	36.5	21.3	32.5
25/20	25	20	0.50	0.46	36.5	21.3	32.5
25/10	25	10	0.48	0.46	36.5	21.3	32.5
30/40	30	40	0.50	0.45	41.5	25.5	37.5
30/20	30	20	0.48	0.45	41.5	25.5	37.5
30/10	30	10	0.47	0.45	41.5	25.5	37.5
40/20	40	20	0.46	0.43	51.5	34.0	47.5
40/10	40	10	0.45	0.43	51.5	34.0	47.5

3.4 Hand-mixed concrete

Concrete for structural purposes shall not be mixed by hand. Where non-structural concrete is required, hand mixing may be carried out subject to the agreement of the Engineer.

The mixing shall be done on a hard-impermeable surface. The materials shall be turned over not less than three times dry, water shall then be sprayed on and the materials again turned over not less than three times in a wet condition and worked together until a mixture of uniform consistency is obtained.

For hand mixed concrete the specified quantities of cement shall be increased by 10% and not more than 0.5 cubic metre shall be mixed at one time. During windy weather efficient precautions shall be taken to prevent cement from being blown away during the process of gauging and mixing.

3.5 Transport of concrete

The concrete shall be transported to the Works by means which shall prevent adulteration, segregation or loss of ingredients, and which shall ensure that the concrete is of the required workability and consistency at the point and time of placing.

The time elapsed between mixing and placing a batch of concrete shall be as short as practicable and, in any case, not longer than will permit completion of placing and compaction before the onset of initial set. If the placing of any batch of concrete is delayed beyond this period, the concrete shall not be placed in the Works.

3.6 Placing of concrete

a) Consent for placing

Concrete shall not be placed in any part of the Works until the Engineer's consent has been given in writing, and the Contractor shall give the Engineer at least 1 full working day's notice of his intention to place concrete.

If concrete placing is not commenced within 24 hours of the Engineer's consent the Contractor shall again request consent as specified above.

b) Preparation of surface to receive concrete

Excavated surfaces on which concrete is to be deposited shall be prepared as set out in Section 3 of this Specification.

Existing concrete surfaces shall be prepared as set out in Clause 414. Before deposition of further concrete, they shall be clean, hard and sound and shall be wet but without any free-standing water.

Any flow of water into an excavation shall be diverted through proper side drains to a sump or be removed by other suitable methods which will prevent washing away the freshly deposited concrete or any of its constituents. Any underdrains constructed for this purpose shall be completely grouted up when they are no longer required by a method agreed by the Engineer.

Unless otherwise instructed by the Engineer surfaces against which concrete is to be placed shall receive a prior coating of mortar mixed in the proportions similar to those of the fines portion in the concrete to be placed. The mortar shall be kept ahead of the concrete. The mortar shall be well worked into all parts of the excavated surface and shall not be less than 5mm thick.

If any fissures have been cleaned out as described in Section 3 of this Specification they shall be filled with mortar or with concrete as instructed by the Engineer.

The amount of mortar placed at any one time shall be limited so that it does not dry out or set before being covered with concrete.

c) Chutes

In general, transportation of concrete by the use of chutes will not be permitted unless approved by the Engineer. The chute shall have a section with round corners and shall have a proper fixed slope so as to allow the concrete to flow satisfactorily and without segregation. The lower end of chute shall be provided with a drop chute not less than 0.6m in height to avoid segregation of falling concrete. The height of drop shall not exceed 1.5m. Chutes shall be protected from direct sunlight, wind and rain.

e) Placing procedures

The concrete shall be deposited as nearly as possible in its final position. It shall be placed so as to avoid segregation of the concrete and displacement of the reinforcement, other embedded items, or formwork. It shall be brought up in layers approximately parallel to the construction joint planes and not exceeding 500mm in compacted thickness unless otherwise permitted or directed by the Engineer, but the layers shall not be thinner than four times the maximum nominal size of aggregate.

Layers shall be placed so that they do not form feather edges nor shall they be placed on a previous layer which has taken its initial set. In order to comply with this requirement, a layer may be started before completion of the preceding layer.

All the concrete in a single bay or pour shall be placed in a continuous operation. It shall be carefully worked round all obstructions, irregularities in the foundations and the like so that all parts are completely full of compacted concrete with no segregation or honeycombing. It shall also be carefully worked round and between waterstops, reinforcement, embedded steelwork and similar items which protrude above the surface of the completed pour.

All work shall be completed on each batch of concrete before its initial set commences and thereafter the concrete shall not be disturbed before it has set hard. No concrete that has partially hardened during transit shall be used in the Works and the transport of concrete from the mixer to the point of placing shall be such that this requirement can be complied with.

Concrete shall not be placed during rain which is sufficiently heavy or prolonged as to wash mortar from coarse aggregate on the exposed faces of fresh concrete. Means shall be provided to remove any water accumulating on the surface of the placed concrete. Concrete shall not be deposited into such accumulation of water.

In drying weather, covers shall be provided for all fresh concrete surfaces which are not being worked on. Water shall not be added to concrete for any reason.

When concrete is discharged above its place of final deposition, segregation shall be prevented by the use of chutes, downpipes, trunking, baffles or other appropriate devices, as approved by the Engineer.

f) Interruptions to placing

If concrete placing is interrupted for any reason and the duration of the interruption cannot be forecast or is likely to be prolonged, the Contractor shall immediately take the necessary action to form a construction joint so as to eliminate as far as possible feather edges and sloping top surfaces and shall thoroughly compact the concrete already placed in accordance with Clause 406. All work on the concrete shall be completed while it is still plastic and it shall not thereafter be disturbed until it is hard enough to resist damage. Plant and materials to comply with this requirement shall be readily available at all times during concrete placing.

Before concreting is resumed after such an interruption the Contractor shall cut out and remove all damaged or uncompacted concrete, feather edges or any other undesirable features and shall leave a clean sound surface against which the fresh concrete may be placed.

If it becomes possible to resume concrete placing without contravening the Specification and the Engineer consents to a resumption, the new concrete shall be thoroughly worked in and compacted against the existing concrete so as to eliminate any cold joints.

g) Dimensions of pours

Unless otherwise agreed by the Engineer, pours shall not be more than two metres high and shall as far as possible have a uniform thickness over the plan area of the pour. Concrete shall be placed to the full planned height of all pours except in the circumstances described in sub-clause 405(d).

The Contractor shall plan the dimensions and sequence of pours in such a way that cracking of the concrete does not take place due to thermal or shrinkage stresses.

h) Placing sequence

The Contractor shall arrange that as far as possible the intervals between placing successive lifts of concrete in one section of the Works are of equal duration. This duration shall normally be not less than three or more than seven days under temperate weather conditions unless otherwise agreed by the Engineer.

Where required by the Engineer to limit the opening of construction joints due to shrinkage, concrete shall not be placed against adjacent concrete which is less than 21 days old.

When the drawings call for contraction gaps in concrete, these shall be of the widths and in the locations shown on the drawings and they shall not be filled until the full-time interval shown on the drawings has elapsed.

3.7 Compaction of concrete

The concrete shall be fully compacted throughout the full extent of the placed layer. It shall be thoroughly worked against the formwork and around any reinforcement and other embedded items, without displacing them. Particular care shall be taken at arises and other confined spaces. Successive layers of the same pour shall be thoroughly worked together.

Concrete shall be compacted with the assistance of mechanical immersion vibrators, unless the Engineer agrees to another method.

Immersion vibrators shall operate at a frequency of between 7,000 and 10,000 cycles per minute. The Contractor shall ensure that vibrators are operated at pressures and voltages not less than those recommended by the manufacturer in order that the compactive effort is not reduced.

A sufficient number of vibrators shall be operated to enable the entire quantity of concrete being placed to be vibrated for the necessary period and, in addition, standby vibrators shall be available for instant use at each place where concrete is being placed.

Where the concrete contains aggregate with a nominal size of 75mm or more, vibrators with a diameter of 100mm or more shall be used.

Vibration shall be continued at each point until the concrete ceases to contract, a thin layer of mortar has appeared on the surface and air bubbles have ceased to appear. Vibrators shall not be used to move concrete laterally and shall be withdrawn slowly to prevent the formation of voids.

Vibration shall not be applied by way of reinforcement nor shall vibrators be allowed to touch reinforcement or other embedded items. The vibrators shall be inserted vertically into the concrete to penetrate the layer underneath at regular spacing. The spacing shall not exceed the distance from the vibrator over which vibration is visibly effective.

3.8 Curing of concrete

a) General

Concrete shall be protected during the first stage of hardening from loss of moisture and from the development of temperature differentials within the concrete sufficient to cause cracking. The methods used for curing shall not cause damage of any kind to the concrete.

Curing shall be continued for as long as may be necessary to achieve the above objectives but in any case, for at least seven days or until the concrete is covered by later construction whichever is the shorter period.

The above objectives are dealt with in sub-clause 407(b) and (c) but nothing shall prevent both objectives being achieved by a single method where circumstances permit.

The curing process shall commence as soon as the concrete is hard enough to resist damage from the process, and in the case of large areas or continuous pours, shall commence on the completed section of the pour before the rest of the pour is finished.

Details of the Contractor's proposals for curing concrete shall be submitted to the Engineer before the placing of concrete commences in the Works.

Formed surfaces may be cured by retaining the formwork in place for the required curing period.

If the use of the foregoing methods is inappropriate, surfaces which will not have further concrete bonded to them and which are not to receive an application of a finish may be cured by the application of a curing compound having an efficiency index of at least 90 percent. Curing compounds shall contain a fugitive dye to enable the extent of the spread to be seen easily.

Curing compound is used on surfaces exposed to the atmosphere shall contain sufficient finely divided flake aluminium in suspension to produce a complete coverage of the surface with a metallic finish when applied at the rate recommended by the manufacturer.

Curing compounds shall become stable and impervious to the evaporation of water from the concrete surface within 60 minutes of application. The material shall not react chemically with the concrete surfaces for at least the first four days of the curing period.

If instructed by the Engineer, the Contractor shall, in addition to the curing provisions set out above provide a suitable form of shading to prevent the direct rays of the sun reaching the concrete surfaces for at least the first four days of the curing period.

b) Loss of moisture

Exposed concrete surfaces shall be closely covered with impermeable sheeting, properly secured to prevent its removal by wind and the development of air spaces beneath it. Joints in the sheeting shall be lapped by at least 300mm.

If for some reason it is not possible to use impermeable sheeting, the Contractor shall keep the exposed surfaces continuously wet by means of a water spray or by covering with a water absorbent material which is kept wet, unless this method conflicts with sub-clause 407(c).

Water used for curing shall be of the same quality as that used for concrete mixing as stated in sub-clause 702(g).

c) Limitation of temperature differential

The Contractor shall limit the development of temperature differentials in concrete after placing by any means appropriate to the circumstances including the following:

i) limiting concrete temperatures at placing as set out in sub-clause 409(b);

ii) use of low heat cement, subject to the agreement of the Engineer;

iii) insulation of exposed concrete surface by insulating blankets. Such blankets shall have an insulation value at least equivalent to 50mm of dry mineral wool;

iv) leaving formwork in place during the curing period. Steel forms shall be suitably insulated on the outside;

v) preventing rapid dissipation of heat from surfaces by shielding from wind;

vi) avoiding the use of water sprays when such use would cause rapid cooling of the surface.

3.9 Protection of fresh concrete

Freshly placed concrete shall be protected from rainfall and from water running over the surface until it is sufficiently hard to resist damage from these causes.

No traffic shall be allowed on any concrete surface until such time as it is hard enough to resist damage by such traffic.

Concrete placed in the Works shall not be subjected to any loading until it has attained at least its nominal strength as defined in Clause 401.

If the Contractor desires to impose loads on newly placed concrete, he shall make at least three test cubes and cure them in the same conditions as the concrete they represent. These cubes shall be tested singly at suitable intervals in order to estimate the time at which the nominal strength is reached.

3.10 Concreting in hot weather

a) General

The Contractor shall prevent damage to concrete arising from exposure to extreme temperatures and shall maintain in good working order all plant and equipment required for this purpose.

In the event that conditions become such that even with the use of the equipment the requirements cannot be met, concrete placing shall immediately cease until such time as the requirements can again be met.

b) Concrete placing in hot weather

During hot weather the Contractor shall take all measures necessary to ensure that the temperature of concrete at the time of placing in the Works does not exceed 30 degrees centigrade and that the concrete does not loose any moisture during transporting and placing.

Such measures may include but are not necessarily limited to the following: -

i) Shielding aggregates from direct sunshine.

ii) Use of a mist water spray on aggregates

iii) Sun shields on mixing plants and transporting equipment.

iv) Cooling the mixing water. If ice is used for this purpose it should preferably be in flake form. Lump ice shall not be allowed to enter the tank supplying the mixer drum.

v) Covering skips closely with polythene sheet so that the latter is in contact with the concrete.

Areas in which concrete is to be placed shall be shielded from direct sunshine and rock or concrete surfaces shall be thoroughly wetted to reduce absorption of water from the concrete placed on or against them.

After concrete in any part of an area has been placed, the selected curing process shall be commenced as soon as possible. If any interval occurs between completion of placing and start of curing, the concrete shall be closely covered during the interval with polythene sheet to prevent loss of moisture.

3.11 Finishes on unformed surfaces

3.11.1 General

The Contractor will be required from an early stage in the contract to prepare samples, for the approval of the Engineer, of the various concrete finishes specified hereafter. Samples are to be prepared using the same materials and the same methods of construction, compaction, curing, etc. as the Contractor proposes to use for executing the full quantity of the work. A record of the mix, water content, method of compaction, any additives used, etc., is to be kept for each sample prepared. When the Engineer has approved a sample it will be kept on site in an approved location. The finishes in construction will be expected to be up to a standard equal to the approved sample. Consistency in cement colour, and the colour, grading and quality of aggregates must be maintained in all finished concrete work.

3.11.2 Mortars

Cement mortar shall consist of one part of Portland cement to three parts sand by volume. The cement/lime mortar shall consist of one part of Portland cement, one part of lime and six parts of sand by volume.

The ingredients of mortar shall be measured in proper gauge boxes on a boarded platform, the ingredients being thoroughly mixed dry, and again whilst adding water. In the case of cement/lime mortar, sand and lime shall be mixed first and then the cement added.

All mortar is to be thoroughly mixed to a uniform consistency with only sufficient water to obtain a plastic condition suitable for toweling. No mortar that has commenced to set is to be used or re-mixed for use.

3.11.3 Tamped finish

Areas so specified shall be finished at the time of casting with a tamped finish to the Engineer's approval produced by an edge board. Board marks are to be made to a true pattern and will generally be at right angles to the traffic flow. Haphazard or diagonal tamping will not be accepted.

3.11.4 Fair face

Fair face surfaces shall be clean, smooth, even, true to form, line and level, and free from all board marks, joint marks, honeycombing, pitting, and other blemishes. Forms are to be provided with a smooth lining of plywood, steel, or other approved material which will achieve the required finish without any general rubbing down. Rubbing down will only be permitted to remove any projecting fins at corners or joints.

3.11.5 Fine face

Fine face surfaces shall be for Fair face above, but to a higher standard obtained from forms provided with an impervious sheet lining of metal or plastics faced plywood in large panels arranged in an approved pattern. Rubbing down shall only be permitted after an inspection by the Engineer. The finished surfaces shall be capable of receiving a painted finish.

3.11.6 Chisel-dressed finish

Chisel-dressed finish is to be carried out on any grade of concrete but not until it is at least 30 days old. The surfaces are to be fully chisel-dressed to remove a maximum of 12 mm (average 9 mm) of the surface by shearing and exposing the aggregate without excessive cracking of the surrounding matrix. Arises of columns, beams, etc., are pre-formed fair face with timber fillets set in the formwork and care must be taken in working up to these to preserve a clean line.

For vertical surfaces of walls and columns particular care must be taken to remove all sharp projections. For beam soffits this requirement is not necessary. All surfaces requiring this treatment are to have margins chisel-dressed by hand for a minimum width of 75 mm commencing from the fillet edge. Thereafter, mechanical chisel-dressing may be used, but the Contractor must ensure that a uniform texture and even plane surface is achieved. The use of sharply pointed steel tools for both hand and mechanical chisel-dressing is essential. Upon completion the surfaces are to be thoroughly wire brushed and washed down.

3.11.7 Protection of finishes

Wherever possible, in-situ exposed concrete finishes should be commenced at the highest level and worked progressively down the building. Precaution shall be taken to avoid staining or discoloration of previously finished concrete faces by leakage of grout from newly placed concrete. The Contractor shall, during all stages of construction, adequately protect all concrete finishes from Damage by leaking grout, knocking, paint stains, falling plaster, etc. In cases of balustrade walls to staircases and members where Damage is otherwise likely, concrete finishes shall be protected by cladding with timber, celotex, or other approved sheeting.

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3.12 Mortar

This clause covers mortar for use ahead of concrete placing, and other uses not covered elsewhere in the Specification.

Mortar shall be composed of fine aggregate complying with sub-clause 702(c) and ordinary Portland cement complying with BS12. The mix proportions shall be as stated on the drawings or elsewhere in this Specification or if not stated shall be one part of cement to two parts of fine aggregate by weight.

Small quantities of mortar may be hand mixed but for amounts over 0.5 cubic metre a mechanical mixer shall be used.

The water content of the mortar shall be as low as possible consistent with the use for which it is required but in any case, the water/cement ratio shall not be more than 0.5.

Mortar which is specified as 'dry pack' shall be mixed with sufficient water for the mix to become cohesive but not plastic when squeezed in the hand. Dry pack mortar shall be rammed into the cavity it is required to fill, using a hand rammer with sufficient force to ensure full compaction.

3.13 Remedial Work to Defective Surfaces

If on stripping any formwork the concrete surface is found to be defective in any way, the Contractor shall make no attempt to remedy such defects prior to the Engineer's inspection and the receipt of any instructions which the Engineer may give.

Defective surfaces shall not be made good by plastering.

Areas of honey combing (of a mild nature) which the Engineer agrees may be repaired shall be cut back to sound concrete or to 75mm whichever is the greater distance. In the case of reinforced concrete the area shall be cut back to at least 25mm clear distance behind the reinforcement or to 75mm, whichever is the greater distance. The cavity shall have sides at right angles to the face of the concrete. After cleaning out with water and compressed air, a thin layer of cement grout shall be brushed on to the concrete surface in the cavity and it shall then be filled immediately with concrete of the same class as the main body but with aggregate larger than 20mm nominal size removed. A form shall be used against the cavity, provided with a lip to enable concrete to be placed. The form shall be filled to a point above the top edge of the cavity.
After seven days the lip of concrete shall be broken off and the surface ground smooth.

Surface irregularities which are outside the limits of tolerance set out in Clause 410 shall be ground down in the manner and to the extent instructed by the Engineer.

Severe honeycombing and defects other than those mentioned above shall be dealt with as instructed by the Engineer.

3.14 Works cube tests

Work cubes are to be made at intervals as required by the Engineer in accordance with C.P. 114, and the Contractor shall provide a continuous record of the concrete work. The cubes shall be made in approved 150 mm moulds in strict accordance with the Code of Practice. Three cubes shall be made on each occasion. Each cube shall be marked with a distinguishing number (numbers) to run consecutively and the date, and a record shall be kept o site giving the following particulars: -

a) Cube No.
b) Date made
c) Location in work
d) 7-Day Test, Date, Strength
e) 28-Day Test, Date, Strength

Cubes shall be forwarded, carriage paid, to an approved Testing Authority, in time to be tested two at 7 days and the remaining one at the discretion of the Engineer. No cube shall be dispatched within three days of casting. Copies of all Works Cube Tests shall be forwarded to the Engineer and one shall be retained on site. If the strengths required above are not attained and maintained during the carrying out of the contract, the Contractor will be required to increase the proportion of cement and/or substitute better

aggregates so as to give concrete which does comply with the requirements of the contract. The Contractor may be required to remove and replace at his own cost any concrete which fails to attain the required strength as ascertained by Works Cube Tests.

4. FORMWORK

4.1 Formwork for concrete

Definitions

Formwork means the surface against which concrete is placed to form a face, together with all the immediate supports to retain it in position while concrete is placed.

False work means the structural elements supporting both the formwork and the concrete until the concrete becomes self-supporting.

A formed face is one which has been cast against formwork.

An exposed face is one which will remain visible when construction has been completed.

4.2 Construction of formwork and falsework

Before construction begins, the Contractor shall submit to the Engineer, drawings showing details of the proposed formwork and false work.

Formwork and false work shall be so constructed that they will support the loads imposed on them by the fresh concrete together with additional stresses imposed by vibrating equipment and by construction traffic, so that after the concrete has hardened the formed faces shall be in the positions shown on the drawings within the tolerances set out in Clause 506.

Ground supports shall be properly founded on footings designed to prevent settlement.

Joints in formwork for exposed faces shall, unless otherwise specified, be evenly spaced and horizontal or vertical and shall be continuous or form a regular pattern.

All joints in formwork including formwork for construction joints shall be tight against the escape of cement, water and fines. Where reinforcement projects through formwork, the form shall fit closely round the bars.

Formwork shall be so designed that it may be easily removed from the work without damage to the faces of the concrete. It shall also incorporate provisions for making minor adjustments in position if required, to ensure the correct location of concrete faces. Due allowance shall be made in the position of all formwork for movement and settlement under the weight of fresh concrete.

Where overhangs in formwork occur, means shall be provided to permit the escape of air and to ensure that the space is filled completely with fully compacted concrete.

Formwork shall be provided for concrete surfaces at slopes of 30 degrees to the horizontal or steeper. Surfaces at slopes less than 20 degrees may be formed by screeding. Surfaces at slopes between 20 degrees and 30 degrees shall generally be formed unless the Contractor can demonstrate to the satisfaction of the Engineer that

such slopes can be screeded with the use of special screed boards to hold the concrete in place during vibration.

Horizontal or inclined formwork to the upper surface of concrete shall be adequately secured against uplift due to the pressure of fresh concrete. Formwork to voids within the body of the concrete shall also be tied down or otherwise secured against floating.

The internal and external angles on concrete surfaces shall be formed with fillets and chamfers of the sizes shown on the drawings unless otherwise instructed by the Engineer.

Supports for formwork for non-water retaining structures may be bolted to previously placed concrete provided the type of bolt used is acceptable to the Engineer. If metal ties through the concrete are used in conjunction with bolts, the metal left in shall not be closer than 50mm to the face of the concrete.

Supports for formwork for water retaining structures may be bolted to previously placed concrete provided the type of bolts and positions of fixing are acceptable to the Engineer. After concreting the Contractor shall remove all support bolts and seal all holes with well rammed cement/sand mortar containing approved waterproofing cement additive. Metal ties which would be left in the concrete shall not be permitted.

Formwork shall not be re-used after it has suffered damage which in the opinion of the Engineer is sufficient to impair the finished surfaces of the concrete.

Where circumstances prevent easy access within the form for cleaning and inspection, temporary openings for this purpose shall be provided through the formwork.

Shear keys shall be provided in all construction joints of the size and shape indicated on the drawings.

Where precast concrete elements are specified for use as permanent formwork or proposed by the Contractor and agreed by the Engineer, they shall comply with the requirements of the Specification. Such elements shall be set true to line and level within the tolerances prescribed for the appropriate class of finish in Clause 506 and fixed so that they cannot move when concrete is placed against them.

4.3 Preparation of formwork

Before any reinforcement is placed into position within formwork, the latter shall be thoroughly cleaned and then dressed with a release agent. The agent shall be either a suitable oil incorporating a wetting agent, an emulsion of water suspended in oil or a low viscosity oil containing chemical agents. The Contractor shall not use an emulsion of oil suspended in water nor any release agent which causes staining or discoloration of the concrete, air holes on the concrete surface, or retards the set of the concrete.

In order to avoid colour difference on adjacent concrete surfaces, only one type of release agent shall be used in any one section of the works.

In cases where it is necessary to fix reinforcement before placing formwork, all surface preparation of formwork shall be carried out before it is placed into position. The

Contractor shall not allow reinforcement or prestressing tendons to be contaminated with formwork release agent.

Before placing concrete all dirt, construction debris and other foreign matter shall be removed completely from within the placing area.

Before concrete placing commences, all wedges and other adjusting devices shall be secured against movement during concrete placing and the Contractor shall maintain a watch on the formwork during placing to ensure that no movement occurs.

4.4 Removal of formwork

Formwork shall be carefully removed without shock or disturbance to the concrete. No formwork shall be removed until the concrete has gained sufficient strength to withstand safely any stresses to which it may thereby be subjected.

The minimum periods which shall elapse between completion of placing concrete and removal of forms are given in Table 5.1 and apply to ambient temperatures higher than 10 degrees centigrade. At lower temperatures or if cement other than ordinary Portland are involved, the Engineer may instruct that longer periods be used.

Alternatively, formwork may be removed when the concrete has attained the strength set out in Table 5.1, provided that the attained strength is determined by making test cubes and curing them under the same conditions as the concrete to which they refer.

Compliance with these requirements shall not relieve the Contractor of his obligation to delay removal of formwork until the removal can be completed without damage to the concrete.

Table 5.1 - MINIMUM PERIODS FOR FORMWORK REMOVAL

Position of Formwork	Min. period for temp over 10 degrees Centigrade	Strength to be attained
Vertical or near vertical faces of mass concrete	24 hours	0.2 C
Vertical or near vertical faces of reinforced walls, beams and columns	48 hours	0.3 C
Underside of arches, beams and slabs (formwork only)	4 days	0.5 C
Supports to underside of arches, beams and slabs	14 days	C
Arched linings in tunnels and underground works	24 hours	4 N/mm^2

Note: C is the nominal strength for the class of concrete used.

If the Contractor wishes to strip formwork from the underside of arches, beams and slabs before the expiry of the period for supports set out above, it shall be designed so that it can be removed without disturbing the supports. The Contractor shall not

remove supports temporarily for the purpose of stripping formwork and subsequently replace them.

As soon as the formwork has been removed, bolt holes in concrete faces other than construction joints which are not required for subsequent operations shall be completely filled with mortar sufficiently dry to prevent any slumping at the face. The mortar shall be mixed in the same proportions as the fine aggregate and cement in the surrounding concrete and with the same materials and shall be finished flush with the face of the concrete.

4.5 Tolerances

All parts of formed concrete surfaces shall be in the positions shown on the drawings within the tolerances set out in Table 5.2.

In cases where the drawings call for tolerances other than those given in Table 5.2 the tolerances shown on the drawings shall take precedence.

Where precast units have been set to a specified tolerance, further adjustments shall be made as necessary to produce a satisfactory straight or curved line. When the Engineer has approved the alignment, the Contractor shall fix the units so that there is no possibility of further movement.

Table 5.2 - TOLERANCES

Class of finish	Tolerances in mm (See Note)		
	A	B	C
F1	10	10	+ 25 to - 10
F2	5	10	+ or - 15
F3	2	5	+ or - 10

Note: The tolerances A, B and C given in the table are defined as follows:

1. Column A is an abrupt irregularity in the surface due to misaligned formwork or defects in the face of the formwork.

2. Column B is a gradual deviation from a plane surface as indicated by a straight edge 3m long. In the case of curved surfaces, the straight edge shall be replaced by a correctly shaped template.

3. Column C is the amount by which the whole or part of a concrete face is displaced from the correct position shown on the drawings.

5. PIPEWORK

5.1 General

General Requirements contain provisions and requirements essential to these Specifications and shall apply to this Clause whether or not referred to herein.

(1) Scope of Work

The Contractor shall furnish plans, temporary works, labour, equipment and material required to complete all Works in acceptable manner, including testing and disinfection and all ancillary works for complete in-place pipelines and structures in accordance with the Contract. The system shall compose of two (2) major components as specified hereunder:

1) Distribution System

Work involves excavation and backfilling of pipe trenches, furnishing. Laying of pipes and fittings, including concrete pipe supports. Also includes the furnishing and installation of air valves and gate valves at locations and elevations indicated on the Drawings, or as may be directed by the Engineer.

2) Water tanks

Work includes complete plumbing system, fittings, valves and appurtenances as shown on the Drawings or as may be directed by the Engineer.

(2) Submittals

Contractor shall submit shop Drawings, construction methodology and the list of all materials including catalogues/brochures for the Engineer's approval, twenty-eight (14) days before the start of any Work specified in this Clause.

In case where materials will require actual test at the manufacturer's yard before approval of the Engineer is given, the Contractor shall schedule the said testing well in advance to prevent undue delay in the Construction.

(3) Quality of Water

Shall be tested and confirmed that the water complies with the WHO Standard for potable water.

5.2 unPlasticised Polyvinyl Chloride (UPVC) Pipes and fittings

U.P.V.C pipes and fittings if required, shall comply with BS 3505 and KS-06-149.

U.P.V.C pipes of diameters less or equal to 50-mm diameter shall be jointed with solvent cement joints in accordance with the manufacturer's instructions. Pipes having diameter larger 50 mm shall be jointed using approved flexible mechanical joints.

All tees, reducers, sockets flange etc. of any diameter are to be jointed to pipes with solvent cement joints.

All jointing and lying of U.P.V.C pipes and fittings shall be carried out strictly in accordance with the manufacturer's instructions.

5.3 Polyethylene (PE) Pipes and fittings

PE Pipes and fittings shall comply with the requirements of ISO 4427 and only PE100 SDR 11 (PN16) or SDR 17 (PN 10) pipes shall be used. The pressure rating of the fittings shall be the same as, or higher than, that of the pipes. The SDR and pressure rating of the pipes and fittings shall be determined by the designer, based on the operating conditions.

The pipe manufacturer shall identify the manufacturer of the resin, the resin type and classification and shall demonstrate that it is certified as meeting the requirements of the PE100+ Association.

Pipes and fittings shall be homogenous throughout and free from visible cracks, holes, foreign inclusions, blisters, dents, scoring, cavities and other defects.

Material shall be uniform in opacity, density, interior smoothness and other physical properties. It shall have adequate resistance to weathering and other ageing from storage for a minimum of two years after manufacture.

All pipes used for the transmission and distribution of potable water shall be black and have blue coloured continuous stripes running their entire length. The number, width and shade of the blue stripes shall be proposed by the pipe manufacturer and be approved by the Engineer.

The pipe manufacturer shall confirm that all fittings meet the same quality requirements as for the pipes to ensure the same performance over the design life cycle. Fittings shall be manufactured in accordance with the requirements of ISO 4427-3.

(1) Pipe Dimensions

Pipe nominal size, ovality, outside diameter and wall thickness shall all comply with the requirements of the tables given in ISO 4427-2 and measured in accordance with ISO 11922 and ISO 3126.

(2) Jointing Pipe of PE Pipes

(i) General

The Contractor shall abide by the following guidelines with regards to jointing PE100 pipes and fittings unless otherwise approved by the Engineer.

- PE100 pipes and fittings of 90 mm OD and above shall joined by butt fusion whenever possible.
- To join PE pipes to metal pipes and fittings such as valves, restrained mechanical transition fittings and stub flanges shall be used.
- When approved by the Engineer, restrained compression fittings that comply with the requirements of this specification and ISO 14236 may be used in place of but fusion fittings for the jointing of PE100 pipes of less than 90 mm OD. If such approval is given, then the bends, tees, branches, reducers and transition fittings shall comprise compression fittings.

(ii) Pipe Fusion Jointing Personnel

All team members that undertake the butt fusion or electro-fusion of pipes and fittings shall have been fully trained in theoretical and practical aspects of pipe welding and the use of appropriate equipment. They shall have undergone an examination and be certified as PE100 pipe welders by either the manufacturer of the welding equipment or a specialist independent third party approved by the Engineer.

(iii) Method Statement

A detailed method statement for PE pipe jointing shall be prepared by the Contractor and submitted to the Engineer for approval. The method statement shall include details of which equipment shall be used and how the work will be performed to ensure compliance with the recommendations of the pipe manufacturer and of this specification. It shall include, but not be limited to:

- Details of the equipment to be employed by the Contractor, together with procedures for its operation, maintenance, periodic inspection and testing.
- Details of the experience and certification of the pipe and fitting jointers that shall be employed by the Contractor.

- Procedures for joint preparation, indicating method and degree of cutting, cleaning, drying, scraping, alignment, support, etc. of the pipe ends to be joined.
- Jointing procedures, specifying the equipment and tools to be employed, together with all relevant parameters such as voltage, temperature, pressure, heating time and cooling down time and the means by which jointing operations shall be controlled.
- Inspection and testing procedures together with proposals for the independent and on site inspection and testing on welds on a regular basis.
- QA/QC procedures
- All safety precautions and procedures.

(a) Butt Fusion Jointing

The equipment used for butt fusion jointing of pipes and fittings shall comply with the requirements of ISO 12176 Part 1. It shall incorporate a control unit that shall comply with the type A requirements of table B.2 of ISO 12176, Part 1 and the following points.

- Automatically pre-set the fusion jointing parameters based on the pipe dimensions, material type and fusion jointing procedure
- Automatically control and monitor the fusion jointing process
- Comply with the requirements of Annex A of ISO 12176, Part 1
- Assign a unique joint number to each joint and have a data retrieval facility to allow historical fusion parameters to be read on the unit's screen and to be exported to an external computer or memory stick

The butt fusion jointing procedures shall comply with the requirements of ISO 21307. The Contractor shall generally follow the single low-pressure fusion jointing procedure described in section 5.1 of ISO 21307.

Only pipes and fittings of the same size, SDR and material are to be butt fusion jointed.

A dummy joint shall be made at the start of each welding session using pipe off cuts of the same size, material and SDR as the pipe being installed. The normal trimming, bead up and full heat soak cycles will be adhered to.

If the pipe size is changed during the day, if the heater plate is allowed to cool below 180°C or if maintenance of the butt fusion equipment is carried out then a new dummy weld shall be performed.

Butt Fusion Joint Inspection

All butt fusion joints shall be inspected in accordance with the requirements of Appendix B of EN 12007 Part 2. Should the joint contain any of the faults described in the standard then the joint shall be cut out and replaced. The inspection shall include the following points:

- The gap between the two single beads shall not be below the fusion surface.
- The displacement between the fused pipes must not exceed 10% of the pipe wall thickness.
- The difference between two single bead widths shall not exceed 10% of the double bead width.

- The weld beads shall be free from all contamination and have a smooth even surface with no evidence of distortion, holes or bubbles
- At the direction of the Engineer external beads shall be removed with an approved tool and inspected for contamination and defects. They shall also undergo bend back testing. Beads should be solid and rounded with a broad root as hollow beads with thin root and curled appearance can be indicative of excessive pressure or no heat soak.
- Each removed bead shall be numbered with its corresponding joint number clearly displayed and removed beads shall be retained for inspection by the Engineer.
- The width of each external bead width shall be measured using bead gauges and the width of the bead shall be within the range given by the pipe and / or welding equipment manufacturer.
- No signs of damage (such as scratches or deep impressions caused by clamps) shall be visible on either side of the joint.
- Any joints the do not comply with the above requirements shall be cut out and a new joint made; the failed joint shall be handed over to the Engineer.
- Records of all tests and inspections shall be maintained by the Contractor and made available for review and approval by the Engineer.

(b) Restrained Compression Fittings

All compression fittings shall be certified by an independent third party as being fully compliant with the requirements of ISO 14236. They shall be tested and certified as being class 1 end load bearing fittings i.e. they shall prevent the pull out of the pipe at their rated operational pressure. Only materials listed in Tables 1 and 2 of ISO 14236 shall be used in the manufacture of the fitting body.

Metallic fittings that not manufactured from copper or copper alloy shall be fully coated to provide protection against corrosion. The coating shall be a factory applied fusion bonded epoxy or a nylon 11 based polyamide coating system, have a minimum dry film thickness of 250 microns and comply with the requirements of either AWWA C224 or WIS 4-52-01. Any bolts, studs or nuts shall be of stainless steel (grade 304 or better) or else be protected with a coating that complies with the requirements of WIS 4-53-03. All buried metallic fittings shall be protected by petroleum impregnated primer, paste and tape prior to back filling.

(c) Restrained Transition Fittings

Transition fittings used to join the pipe to flanged fittings and pipes made of other materials shall be certified by an independent third party as being fully compliant with the class 1 requirement of ISO 14236 or at least the Type 2 requirement of WIS 4-24-01 i.e. they shall prevent the pull out of the pipe at their rated operational pressure.

Metallic fittings shall be fully coated to provide protection against corrosion. The coating shall be a factory applied fusion bonded epoxy or a nylon 11 based polyamide coating system, have a minimum dry film thickness of 250 microns and comply with the requirements of either AWWA C224 or WIS 4-52-01. Any bolts, studs or nuts shall be of stainless steel (grade 304 or better) or else be protected with a coating that complies with the requirements of WIS 4-53-03. All buried metallic fittings shall be protected by petroleum impregnated primer, paste and tape prior to back filling.

5.4 Galvanized Pipes and Specials

All piping shall conform to BS 1387 for Medium Piping. The pipes shall be screwed, socketed or flanged. Threaded joints shall conform to BS 21. Galvanised coatings shall be of the hot dipped type and conform to BS 729 Coating weight shall have be a minimum weight of 400 gms~m2.

All specials shall be of such dimensions as will mate with the piping supplied. Screw down stop valves shall conform to 85 1010, Barrel Nipples shall conform to BS 21 and all other specials shall conform to BS 1256.

All pipes and fittings supplied shall be certified by the manufacturer to have been tested in accordance with the relevant Standard Specification.

5.5 Valves and appurtenances

1) General

(a) Valve brochures/catalogues of at least three (3) manufacturers shall be submitted to the Engineer for selection and approval. Caulked-typed bell ends shall not be allowed.

(b) All valves shall be provided with direction arrow for opening, the name of the manufacturer and the working pressure for which they are designed, cast in raised letters upon an appropriate part of the body. In addition, valves designed for one-way flow only shall have a direction arrow cast on the body.

(c) All interior parts of valves manufactured of bronze (except valve stems) shall conform to the requirements of the latest editions of BS 5163 unless otherwise stated.

(d) Gate, check and air valves shall be suitable for use under operating conditions of 100 meters of water column. Nuts and valve shall turn counterclockwise to open.

(e) The Contractor shall submit manufacturer's Certified Drawings showing the principal dimensions, construction details and materials used for all parts of the valve and full details of valve stem extensions, including material, dimensions, fabrication, torque limits, method of connection to the valve and box and stem guides.

2) Gate Valves

Gate valves shall comply with the requirements of BS 5163. The gate valves shall be suitable for use in pipelines and for the operating pressure equipment to a head of 100 meters of water.

The gate valves shall be flanged. The dimensions and drilling of flanges shall be in accordance with BS 4504. Flanges shall be machined flat. Flanges shall be PN16 complying 'with BS 4504

Valves shall be securely fixed with the spindle in vertical position, unless otherwise stated. They shall be checked for ease of operation and water tightness. Valve glands shall be repacked if necessary.

Unless otherwise stated, sluice valves should be able to withstand the working pressure of the class of pipe adjoining the valve.

(a) Gate valves larger than 80mm nominal bore and above, other than those required for fitting to buried water mains shall be of Cast Iron construction, in accordance with the requirements of BS 3464.

(b) All gate valves required for fitting to buried water mains shall be of Cast Iron construction in accordance with the requirements of BS 5163.

(c) All gate valves up to and including 65mm nominal bore shall be of Bronze construction in accordance with the requirements of BS 5154 and BS EN 12288:2003.

(d) Gate Valves for domestic water shall be 980 KPa (10kgf/cm2) working pressure.

(e) Tee-Handle Valve Keys

Supply two (2) tee-handle valve keys with a minimum length of 1.80 meter for the operation of buried/below ground valves.

(f) Valve Boxes

Cast iron valve box shall be provided for gate valves installed less than 1.5m deep measured from finished surface to top of pipe. Valve box shall be of the telescopic slide type or screw-type with hinged cover installed as shown in the Drawings.

3) Air Release Valves

Small orifice type air valves shall be designed to automatically operate to exhaust accumulated air under pressure.

4) Check Valves

(a) All check or non-return valves 80mm nominal bore and above shall be of the swing check type of Cast Iron construction in accordance with the requirement of BS EN 12334:2001.

(b) All check valves up to and including 65mm nominal bore shall be of Bronze construction in accordance with the requirements of BS EN 12333:2001

(c) Check Valves for domestic water shall be 980 KPa (10kgf/cm2) working pressure.

(d) Check Valves attached to pumps discharge pipe shall be installed to protect the pipe from water hammer; check valve type with by-pass assembly, designed and produced by pump manufacturer or approved equal.

5) Ball Valves

All ball valves for use in connection with cold water services shall be of the Portsmouth type in accordance with the requirements of B.S.1212, constructed from Bronze or other corrosion resistant materials. These valves fall into three pressure classifications as follows:

Pressure Classification	Maximum Pressure KPa (gauge)
Low	358
Medium	772
High	1262

(7) Water Meter

1) Submittal

At least (28) twenty-eight days prior to the start of Work, the Contractor shall submit a manufacturer's test data and material certification that the water meters including accessories meet the requirements specified herein. The Contractor shall submit the manufacturer's Drawings, information, Shop Drawings, brochures, descriptions and manufacturer's specifications together with the Certificate.

For each consignment, the Contractor shall submit, in triplicate a Certificate that water meters have been inspected, tested and accepted from the approved manufacturer in accordance with the Contract.

2) Water Meters

(a) Water meters of nominal size 19 mm to 38 mm shall be in accordance with AWWA C 700, ASTM Standard or approved equal, with cast bronze body, vane wheel, double jet type with strainers and direct reading water flow accumulator, with union coupling ends and dry type indicating elements (magnetic or other).

(b) Water meters of nominal size 50 mm and above shall be constructed in accordance with ASTM standard or AWWA C-700 with cast iron body, vane wheel, direct stream type with strainer and direct reading water flow accumulator, flanged ends, with dry type indicating elements (magnetic or other).

(c) Sealing

Each meter shall be supplied with copper wire and lead seal system to discourage unauthorized opening or removal of the meter and also to indicate if such unauthorized action has occurred. All elements of the sealing system, including length of wire, location of wire holes, etc., shall be suitable for covering all possible means of tampering, in particular disturbance of the coupling nuts, accuracy of the adjustment device or of the register assembly. The lead seal shall be blank and suitable for sealing by a compression tool, supplied by others, containing a unique embossing mark.

(d) Tamper-Resistant Device

Each meter shall incorporate a tamper-resistant device which shall function separately from the wire and lead seal, and which is intended to deter entry into the register assembly.

(e) Shop Testing

The approved manufacturer shall perform the following test for every water meter.

After machining each body, casing and each tailpiece shall be subjected to air or water hydrostatic pressure of 200 meters of water column for one (1) minute. Should any leakage be observed, the body or tailpiece shall be replaced at Contractor's expense.

After assembly, each completed meter shall be subjected to a hydrostatic pressure of 200 meters of water column for one (1) minute. Should any leakage be observed the necessary adjustments shall be made to stop the leakage otherwise the meter shall be rejected.

5.6 Manufacturer's instructions

The contractor shall be responsible for obtaining copies of any manufacturer's instructions for pipe laying and jointing and shall familiarizes himself and his employees with these instructions. If the special/new techniques are specified, the contractor shall make it upon himself to properly train his/her staff on the new installation technique.

All necessary tools and equipment required for the laying, jointing and testing of pipes and joints shall be provided by the contractor at no extra costs.

5.7 Trench Excavation

Excavated material shall be placed tidily and compactly at the sides of the trench so as to occupy as little space as possible and to create as little nuisance as possible.

The bottom of the trench shall be absolutely smooth and completely free from stones and sharp objects so as to ensure that the pipes rest uniformly upon original ground throughout its length.

Backfilling with excavated material beneath the pipe at low spots will not be permitted. Excavation below the bottom of the trench at pipe joints must be kept to a minimum.

If the bottom of the trench materials that is unsuitable for pipe laying, the Engineer may instruct the contractor to excavate below formation level and backfill to formation with suitable approved material properly compacted.

No pipe laying is to take place until the bottom of the trench is carefully examined by the engineer's representative.

(a) Minimum trench depth

The minimum depth for pipe trenches shall be that which ensure minimum cover of 600mm to the crown of the pipe.

(b) Backfilling in pipe trenches

Backfilling around the pipe and to a height of 300 mm above it is to be carried out by using material that is free from stones and carefully compacted in layers not exceeding 150 mm thick.

Backfill to trenches shall be properly compacted and subsequent subsidence shall be the contractor's responsibility and shall make it good at his own expense.

All topsoil shall be kept aside during excavation and be replaced after backfilling.

All surplus material from the excavations shall be disposed.

(c) Removal of timbering

All timbering materials shall be removed from trenches before or during backfilling unless, in the opinion of the Engineer, its removal will cause any subsidence in which case he may instruct the contractor to backfill leaving the timbering in place.

(d) Reinstatement

Immediately backfilling of trenches has been completed, temporary reinstatement of the ground surface shall take place.

When in the opinion of the Engineer's representative a suitable period as elapsed after the temporary reinstatement and expects no further settlement, he shall allow the contractor to carry out the permanent reinstatement. This shall in any way relieve the contractor of his responsibility for the reinstatement and, should any further unforeseen settlement take place, the contractor will be required to make good the reinstatement at his own expense.

Permanent reinstatement means the ground surface shall be restored to its original form and condition.

5.8 Handling and storing pipes

Particular care shall be taken during loading, unloading, handling and transportation to avoid distortion, flattening, denting, scoring or any Damage to external or internal coating, sheathing or lining of the pipes, fittings, etc.

Pipes shall be stacked clear of the ground on the timbers of adequate dimensions to prevent Damage to the pipes and successive tiers shall be separated by timber of similar dimensions. Wooden wedges shall be fixed to these timbers to prevent the wedges from rolling.

Fittings etc. shall be stacked clear of the ground on timbers not more than 1 tier high.

All valves rubber joint rings, gaskets, nuts, bolts, washers and similar fittings shall be stored in approved locked premises and shall not be distributed to the trench until immediately prior to fixing. All rubber joint rings and gaskets must be stored in a cool place.

All pipes and fitting should be stored under cover and protected from the weather to the satisfaction of the Engineer.

5.9 Examination of pipes

Before laying each pipe must carefully be examined for Damage. Any defects in the external coating or internal lining shall be made good. The pipes shall be carefully examined for cracks or chipped ends. Damaged ends shall be cut off beyond the damaged area and machined true.

When requested, the pipe manufacturer shall provide access to and copies of all material certificates and inspection and test results obtained in the course of quality verification

5.10 Marking

The marking information and its sequence shall comply with the relevant part of ISO 4427. All pipes and injection moulded fittings, including test samples, shall be clearly and permanently marked using indent printing in a colour that contrasts with the pipe.

The marking of fabricated fittings shall be proposed by the pipe manufacturer and approved by the Engineer.

5.11 Laying of pipes

5.11.1 General

Laying of the pipe and making of connections shall be undertaken in a dry trench.

Pipe handling shall be in accordance with this specification and the manufacturer's recommendations and all exposed PE pipe shall be properly supported and protected from mechanical damage.

The induction of stresses in the pipe or in joints during installation shall be avoided where possible and the following precautions shall be taken:

- Ensure that the pipe is not damaged by coming in to contact with sharp or abrasive materials during handling, jointing or installation and that it is regularly supported along its length.
- When pipes are pulled as part of the jointing or laying process care shall be taken to ensure that the drag force does not exceeding the allowable force as specified by the pipe manufacturer. Pipes shall only be pulled when they are supported by roller assemblies and are free of the ground surface and other obstructions in order to ensure that they are not damaged during the process.
- The contractor shall comply with the minimum allowable bending radii specified in section 8.2 of this specification.
- Ensure that the trench is in compliance with the requirements of this specification and that proper bed and surround material are used. None of the material has a diameter of greater than one tenth of the pipe outside diameter (OD).
- Whilst placing the bed and surround material ensure that no stones or other hard materials impinge on the surface of the pipe
- If the pipe is laid in a sleeve, ensure that the sleeve ends are fitted in such way that no stress or cutting effect can be transmitted to the PE carrier pipe.

All pipes shall be laid strictly to the lines, levels and gradients as shown on the drawings unless where otherwise directed by the Engineer.

Mains shall be boned to even gradients using site rails no dips or bumps permitted.

All pipes shall be solidly bedded on the trench bottom. Joint holes shall be as small as possible and filled in compactly before the refilling of the trench commences.

The contractor shall make full allowance for all cuttings and jointing of pipes.

5.11.2 Surface water

No surface water or other extraneous matter shall be allowed to enter the pipes during or after laying. Should this happen, the contractor shall arrange for the necessary cleaning of the pipe at his own expense.

5.11.3 Painting of exposed pipes, valves, fittings and metalwork

All pipes, valves, tubes, manhole covers other than domestic connections, that are left exposed to the air at river crossings, in manholes, chambers etc., except where galvanized, shall be thoroughly cleaned and painted with two coats of approved bituminous paint after erection.

5.12 Testing of Pipes

5.12.1 General

Upon substantial completion of the pipeline or major sections, the line shall be cleaned and hydrostatically tested to prove integrity of the pipeline section and to detect any leakage prior to commissioning. Testing shall be performed in accordance with the Finnish Standard SFS 3115E and the procedure described below. The Contractor shall supply all necessary fittings, equipment and facilities required to undertake the testing.

5.12.2 Method Statement

The Contractor shall prepare a detailed Method Statement for the pressure test that shall follow the procedure described below and be subject to the approval of the Engineer.

(a) Outline Test Procedure

Seal the pipeline. Fix all blank flanges. Remove air valves. Remove all on line equipment that may be damaged by high pressure.

Only test against blank flanges, do not attempt to test against closed valves.

Cover the pipe with sufficient backfill to protect it from direct sunlight, leaving joints exposed where practical. If backfilling is not practicable schedule the tests for early morning or evening.

Fill the pipeline from the lowest point. Bleed the air from all high points and flange points where it is possible and tighten once water begins to spill.

When the line is full, close off the filling valve and check all flanges and the small diameter test pipework for leaks.

(b) Phase 1

Commence raising the pressure at the filling point to the operating pressure or a pressure of 5 bar, whichever is higher. Hold this pressure for a period of 2 hours and add water whenever the pressure drops by 0.2 bar in order to maintain a steady pressure, whilst visually inspect the pipe length for leakage.

(c) Phase 2

After two hours raise the pressure to 1.3 times the operating pressure or 6.5 bar, whichever is higher, as quickly as is practical. Again maintain this pressure for two hours by adding water whenever the pressure drops by 0.2 bar. Visually inspect the pipe length for leakage.

(d) Phase 3

At the end of the second two hours release the pressure back down to the phase I level i.e. the operating pressure or 5 bar, within a period of no more than 30 minutes and as quickly as is practical, in a controlled manner.

(e) Phase 3 – Case 1

If after one hour the pressure in the pipelines remains at or above the operational pressure, the test is considered to be completed with the pipeline passing the hydrostatic test.

(f) Phase 3 – Case 2

If after one hour the pressure in the pipeline has fallen below the operational pressure, water shall be added to raise the pressure back to the operating pressure level, having first noted the low pressure before adding any water.

(g) Phase 3 – Case 2

Measure the added water by draining it off into a measuring cylinder. (i.e. reduce pressure to the previously recorded low value and save the water bled off). The measured quantity is then compared against the allowable quantity to determine if the pipeline passes the hydrostatic pressure test.

Figure 1 Graphical Representation of the Hydrostatic Test Process Case 1 – Pipeline passes test without adding any make up water

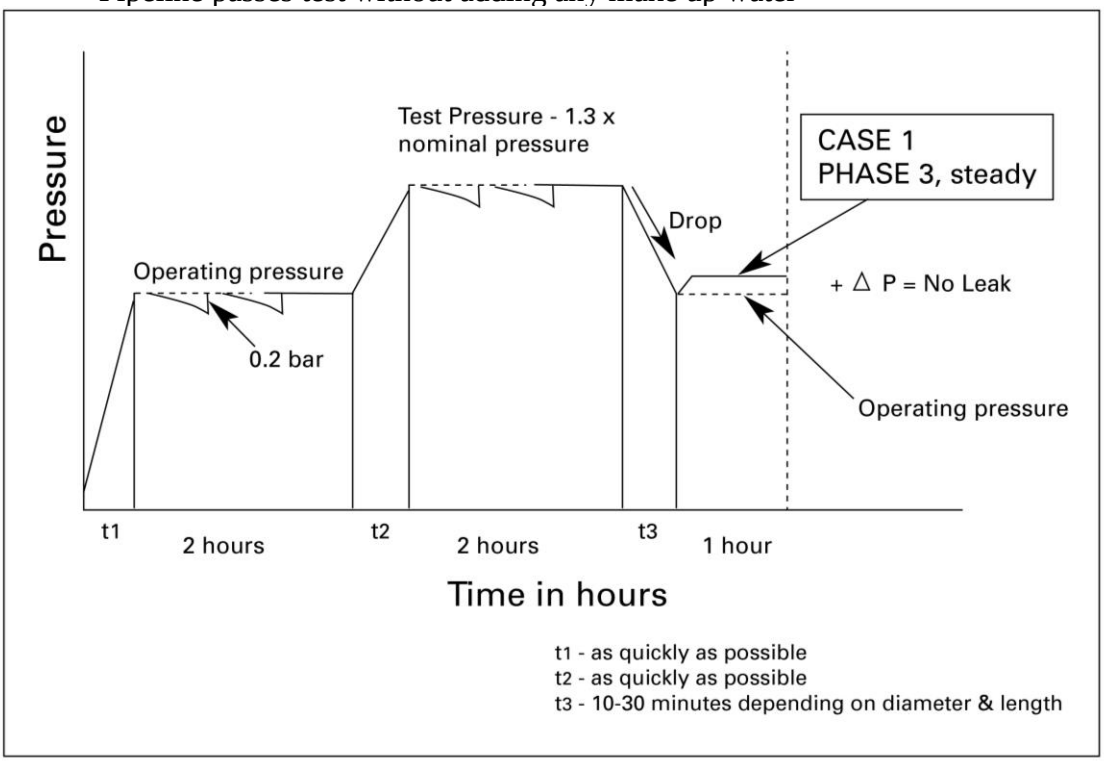
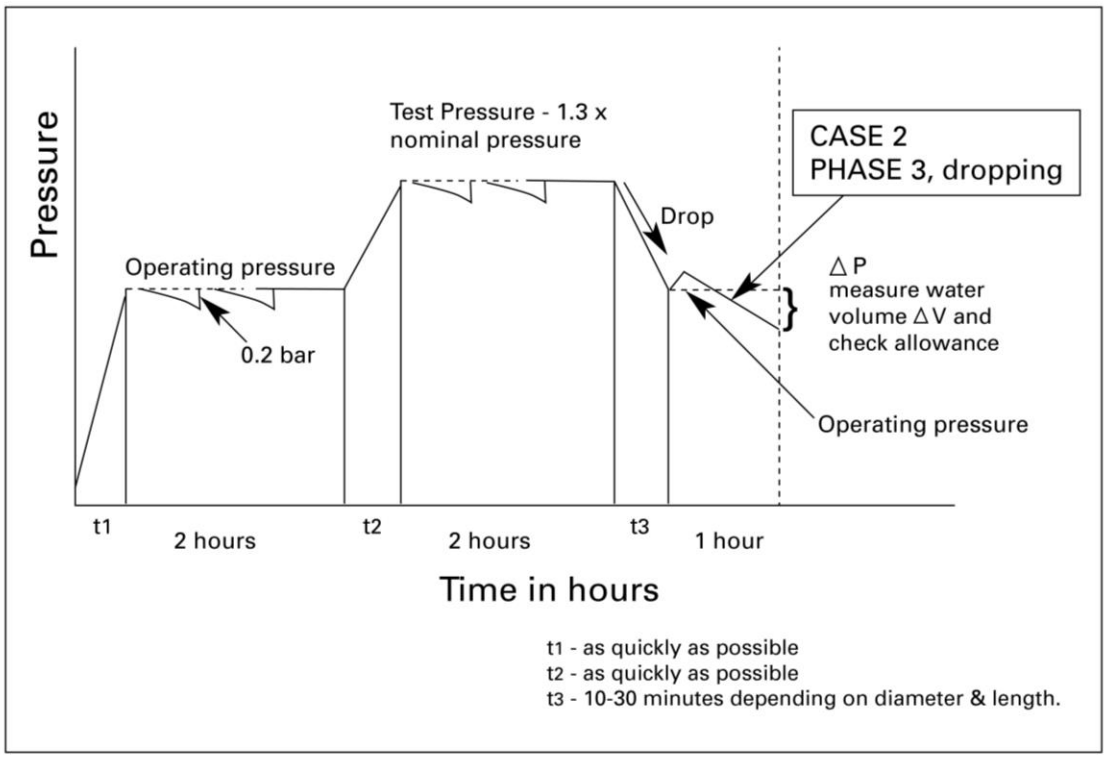


Figure 2 Graphical Representation of the Hydrostatic Test Process Case 2 – Water to be added to determine if the pipeline passes or fails



5.12.3 Test Result

If during Phase 3 the pressure within the pipeline remains at or above the operational pressure of the pipeline for a period of at least one hour, the pipeline is considered to have passed the hydrostatic test.

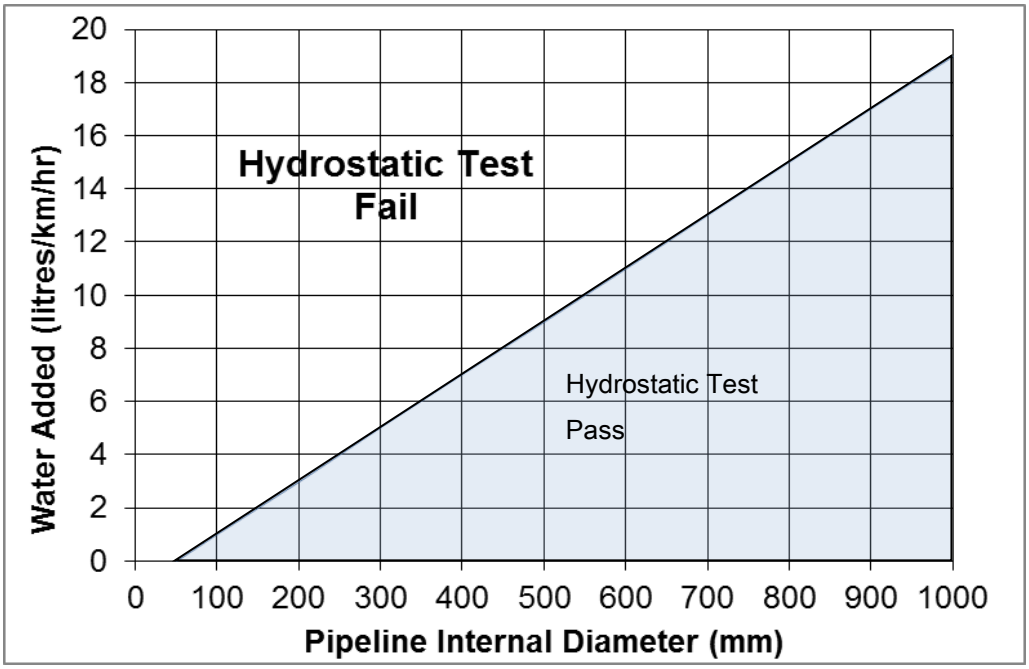
If water needs to be added the pipeline is considered to have passed the hydrostatic test if the quantity of water added in terms of litres of water per km of pipeline length per hour of the phase 3 period is less than that given in the following expression and in Figure 3.

$Q \leq Di/50 - 1$ (litres / km/ hour)

Q = added water in litres.

Di = internal diameter for the pipeline in mm.

Figure 3. Hydrostatic Test – Allowable Quantities of 'Make Up' Water



5.12.4 Notes on Test Equipment

The pressure gauge shall be calibrated, certified and to accurate to 0.1 bar. It shall be connected to the feed pipework.

The small diameter test pipework shall include a bleed valve at upper end of the pipeline and at all high points together with feed pipework and valve at the lower end of the pipeline. The feed pipework shall include a means of draining off the water in to a measuring cylinder that shall have a capacity of at least 2 litres capacity, graduated to 100 mls.

The Contractor shall also have a thermometer for air and water temperature measurement.

5.12.5 Differences in elevation

Care should be taken not to over pressure the lower end of the system during testing. Gauges should always be placed at the lower end of the length under test. As far as possible the difference between the lower and upper end should be kept to one bar. It is recognized that this may not always be possible when longer lengths are being tested, or where the slope of the pipeline makes it impractical.

5.12.6 Test pressures at elevated temperature

Where the phase II pressure is within the pressure rating of the pipe and test temperatures are less than 30 ^{O}C no adjustment of test pressure is necessary.

When ambient temperatures at the time of test are over 30 ^{O}C or higher and the test pressures exceed the pressure rating of the pipe (after being derated in accordance with Annex A of ISO 4427-1) then it is necessary to modify the test pressure according to the table below or as agreed with the pipe manufacturer.

Table 7 – Reduction factor to be applied to test pressures at high ambient temperatures

Test Temp. (^{O}C)	30	35	40	45	50	55	60
Multiplier	0.9	0.85	0.8	0.75	0.7	0.65	0.6

5.12.7 Additional Notes

Care should be taken that any mechanical elements on the system are protected from elevated pressure or completely removed from the pipeline.

Do not subject the line to prolonged over-pressure. Always aim to complete the procedure within one working day.

During the summer make sure that the pipe is not subject to direct sunlight during testing.

During pressure testing pay full attention to the HSE aspects of the procedure. In particular keep the general public away from high pressure test areas.

The test equipment must be capable of pressurizing the test length within a reasonable time. If the procedure becomes protracted (beyond one working day) the test length may be modified or reviewed. Extremely long test lengths may be subject to special procedures.

5.13 Disinfection and Flushing of Water Pipelines

5.13.1 General

All water lines shall be disinfected by The Contractor to the satisfaction of the Engineer.

5.13.2 Method Statement

The Contractor shall prepare a detailed method statement for disinfection. It shall describe in detail how the Contractor proposes to perform the various disinfection activities to ensure compliance with the requirements as set out in this specification and applicable standards, together with the requirements of the relevant authorities.

5.14 Disinfection and Flushing

After completion of the hydrostatic test and before the pipeline is taken over by the client and placed in service it shall be disinfected and flushed as per AWWA C651 or as directed by the Engineer. One (1) week before the Contractor intends to undertake disinfecting/flushing of all or part of the pipelines, the Contractor shall submit a detailed proposal for the work showing the quantity of water required. This quantity of water may be obtained by the Contractor from the nearest available source approved by the Engineer.

The chlorine dose shall be obtained from a sodium hypochlorite solution or other suitable solution to be approved by the Engineer. Chlorine Dioxide shall not be used. Samples taken from the pipeline during disinfection at locations directed by the Engineer shall be checked by a suitable comparator in order to ensure that the sterilising liquid is present throughout the system and at sufficient concentration.

Sodium Hypochlorite shall not be added directly to the pipe and the free chlorine concentration shall not exceed 25 mg/l.

At the end of the 24-hour period at operating pressure the chlorine concentration shall be checked. If there is less than 1 mg/l of free available chlorine in the water, more sodium hypochlorite solution shall be introduced and left for a further 24-hour period after which the free available chlorine concentration shall be checked again. This procedure shall be repeated as necessary until the available free chlorine taken after 24 hours exceeds 1 mg/l for all samples taken from the length of pipeline under test. If the concentration of free available chlorine exceeds 5 mg/l at any point the after 48 hours the pipeline shall be flushed out until the concentration falls below this level.

After all testing and disinfection has been completed and the pipeline is ready for handing over in all other respects including the installation of connections where appropriate, the new pipeline shall be flushed out with potable water from the existing

mains to which the new pipeline or network is or will be connected. Flushing entry and exit points shall be designed to allow a minimum of 1.0m/s water velocity in the main pipeline to remove any sand or other debris. The quantity of flushing water shall be calculated as the equivalent to 3 times the volume of the pipeline to be flushed unless directed otherwise.

It shall be a condition that the water in the existing network at the point of extraction shall register a minimum of 0.4 mg/l of free available chlorine when tested with a site comparator prior to any approval being given to commence flushing. If a reading of less than this is obtained the Engineer shall be informed and the Contractor instructed accordingly.

Once flushed, the water in the new pipelines shall be allowed to stand for a further 24 hours. Samples shall then be taken at locations instructed by the Engineer and immediately submitted for chemical and bacteriological testing at approved laboratories. If available, chemical and bacteriological tests shall normally be undertaken at the End Users laboratory and a charge may be made for testing. All charges for water sample testing shall be paid by the Contractor.

5.14.1 Acceptance Criteria for Disinfection

The pipeline shall not be considered acceptable until faecal coliforms are undetectable in a 100 ml sample, the bacterial count is within approved limits, the recorded total chlorine content is a minimum of 0.2 mg/l and the pH is within acceptable limits i.e. between 7.0 and 9.0 unless otherwise instructed by the Engineer.

If the tests show that a satisfactory drinking water standard has not been achieved, the Contractor shall repeat the disinfection and flushing process, all at their own expense, until these requirements are met.

Flushing water shall be discharged via temporary discharge lines to the surrounding open areas, into the existing storm water system or into water courses, as directed by the relevant authorities. Before being discharged the flushing water shall pass through a baffled tank or similar equipment that shall be used to de-chlorinate the water.

5.15 Concrete surround for pipes

Bed the draw off pipe and surround it with Class 15 concrete as specified. The sequence of work will involve:

(a) Lay the Concrete bed
(b) Lay, and joint the pipes on the Concrete bed.
(c) After the pipes have been tested complete the Concrete surround.

6. MATERIALS

6.1 General

The approval in writing or otherwise by the Engineer of any materials shall not in any way whatsoever relieve the Contractor from any liability or obligation under the Contract and no claim by the Contractor on account of the failure, insufficiency or unsuitability of any such materials will be entertained.

a) All items shall be suitable for water works purposes and for use with cold water installation and operation being in a tropical climate.

b) All items hereinafter specified shall be to such other Standard or Specification which in the opinion of the Engineer provides for a quality of material and workmanship not inferior to the Standard quoted. The Standard or Specification must be submitted to the Engineer for approval before commencement of work.

c) All ferrous pipes and fittings shall be coated with a protective paint suitable for use in and transport through a tropical climate.

d) The Contractor shall supply to the Employer a certificate stating that each item supplied has been subjected to the tests hereinafter laid down and conforms in all respects to the said Specification.

e) The Contractor shall provide adequate protection to all piping, flanged items and valves so as to guard effectively against damage in transit and storage and ingress of foreign matter inside the valves.

f) All pipework and fittings shall be subjected to a works hydrostatic test pressure which shall be not less than twice the maximum operating pressure.

g) The Contractor should exercise diligence to provide the best material.

h) Where applicable the manufacturer's Specification should accompany all offers. The name of the manufacturer must in every case be stated.

j) Where necessary the Contractor shall provide rubber gaskets to comply with BS 4255 and all other bolts, nuts, washers, etc. to undertake jointing at fittings etc.

k) Any articles required under this Contract which are found to be faulty due to a crack, flaw or any other reason or is not in accordance with the Specification stipulated will not be accepted nor will the Employer be liable for any charges in respect of such an article. Where any such rejected article can, in the opinion of the Engineer, be rendered usable, the Contractor may deal with it accordingly and include it in the Contract at a price to be mutually agreed. Straight pipes which have been cut will be accepted at the discretion of the Engineer, provided the length is not less than 4 metres or two thirds of the standard length whichever is the lesser and will be priced pro-rata.

l) Wherever possible, samples of pipes and fittings shall be submitted for approval of the Engineer prior to the Contractor obtaining the total requirements.

6.2 Galvanised pipes and specials

All piping shall conform to BS 1387 for "Medium" Piping. The pipes shall be screwed and socketed, coupled or flanged.

All specials shall be of such dimensions as will mate with the piping supplied. Screw down stop valves shall conform to BS 1873. Barrel nipples shall conform to BS 1387 and all other specials shall conform to BS 1387.

All pipes supplied shall be certified by the manufacturer to have been tested in accordance with the relevant Standard Specification.

6.3 Gate valves

Gate valves shall comply with the requirements of BS 5163.

The gate valves shall be suitable for use in pipelines and for the operating pressure to a head of 160 metres or 250 metres of water (NP 16) or NP 25.

The gate valves shall be double flanged. The dimensions and drilling of flanges shall be in accordance with BS 10/ BS 4504. Flanges shall be machined flat. Flanges shall be NP 16 / NP 25 complying with BS 10/ BS 4504.

Spindles of the gate valves shall be provided with cast iron caps conforming to the requirements as specified under "Valve Caps" in BS 2456 or handwheels if so specified.

The spindles of the gate valves shall be of the non-rising type and screwed so as to close the valves when rotated in a clockwise direction. The direction of closing shall be clearly cast on the valve cap or handwheel.

The gate valves shall be subject to "Closed End Tests" in accordance with the procedure set out in BS 5163.

The gate valves shall be suitable for opening and closing against an unbalanced head by manual operation.

6.4 Paints

All priming, undercoating and finishing paints shall be in accordance with BS 4800.

The painting of all building works shall comprise a special paint recommended for external work while all other paints, plastic emulsion coating etc. are to be of an approved manufacturer. All paints, distempers etc. shall be delivered on site intact in the original drums or tins, and shall be mixed and applied in accordance with the manufacturer's printed directions. The only addition that will be allowed to be made will be liquid thinners, driers etc. supplied by the makers for the purpose.

All surfaces must be thoroughly cleaned down prior to painting and decorating work and no external painting shall be carried out in rainy weather. All paint must be thoroughly well worked on and excess of paint in any coat must be avoided.

All colours will be selected by the Engineer from the standard range of colours.

6.5 Precast concrete units

Precast concrete covers to be precast units for use in the works, whether instructed under the Contract or proposed by the Contractor.

a) Formwork for Precast Units

Moulds shall be so constructed that they do not suffer distortion or dimensional changes during use and are tight against loss of cement grout or fines from the concrete.

Moulds shall be set up on firm foundations so that no settlement occurs under the weight of the fresh concrete.
Moulds shall be constructed so that units may be removed from them without sustaining any damage.

Release agents used for demoulding shall not stain the concrete or affect its properties in any way.

b) Reinforcement for Precast Units

Reinforcement shall comply with BS4449. Cover to main reinforcement shall be as shown on the drawings, or if not shown shall be not less than 25mm or the diameter of the bar, whichever is the greater. Cover on distribution steel shall not be less than 15mm or the diameter of the bar whichever is the greater.

Bars shall be spaced so that the minimum clear distance between them is the maximum nominal aggregate size plus five millimetres but in any case not less than the diameter of the bars.

Bars may be placed in pairs provided that there are no laps in the paired lengths.

c) Casting of Units

Concrete for precast units shall comply with relevant specifications for concrete using the class of concrete specified on the drawings.

If lightweight aggregates are specified, they shall comply with BS 3797.

The area in which units are cast shall be adequately protected from the weather so that the process is not affected by rain, sun or drying winds.

d) Curing Precast Units

Requirements for curing shall be generally as set out in Clause 407.

The Contractor shall ensure that units do not suffer any loss of moisture or sudden changes of temperature for at least four days after casting. If a water spray is used for curing, the water shall be at a temperature within 5 degrees centigrade of the temperature of the unit being cured.

If Contractor proposes curing at elevated temperatures, the method shall be subject to the agreement of the Engineer and shall include means whereby units are heated and subsequently cooled evenly without sudden changes of temperature.

e) Dimensional Tolerances of Precast Units

Units shall be accurately formed to the dimensions shown on the drawings unless closer tolerances are called for by the Engineer.

f) Surface Finish of Precast Units

The formed faces of precast units shall be finished to Class F3 as set out in Clause 505(C) unless another class of finish is specified on the drawings.

Free faces shall be finished to Class UF2 unless another class of finish is specified on the drawings.

In cases where a special finish is required a trial panel shall be constructed by the Contractor which after approval by the Engineer shall be kept available for inspection at the place of casting and production units shall thereafter match the approved pattern.

Those parts of the unit which are to be joined to other units or to in-situ concrete shall be brushed with a stiff brush before the concrete has fully hardened. Alternatively, if the concrete has been allowed to harden, the surfaces shall be roughened by sand blasting or by the use of a needle gun.

g) Handling and Storage of Precast Units

Precast units shall be handled in a manner which will not cause damage of any kind and shall be stored on a hard impermeable base.

Prestressed units and large precast normally reinforced units shall be handled and stored so that no stresses shall be induced in excess of those which they will incur in their final positions in the Works unless they have been designed to resist such stresses.

Units shall be provided with adequate lifting holes or loops, placed in the locations shown on the drawings or agreed by the Engineer and they shall be lifted only by such holes or loops. Where it is not possible to provide holes or loops, suitable sling positions shall be indicated in paint on the units.

Units shall be marked indelibly with the reference number and date of casting and shall be stacked on suitable packers which will not damage the concrete or stain the surfaces. Not more than two packers shall be placed under each unit

and these shall be located either at the positions of the permanent support points or in positions such that the induced stresses in the unit will be a minimum.

h) Testing Precast Units

Precast units shall be capable of safely sustaining the loads which they have been designed to carry. The Contractor shall subject units selected by the Engineer to load tests simulating the working conditions. Details of such tests shall be agreed between the Engineer and the Contractor.

In the case of units subject to bending loads the test piece shall be supported at full span and a loading equivalent to 1.25 times the sum of the live and dead loads which were assumed in the design shall be maintained for one hour without the appearance of any signs of distress. The recovery one hour after the removal of load shall be not less than 75 per cent of the full load deflection.

If the unit fails to meet the above requirements, further tests shall be carried out on two more units. If either of these fail the whole batch of units will be rejected.

If the Engineer so requires, a test to destruction shall also be carried out which on units subject to bending shall be as follows:-

The units shall be supported at full span and a load applied in increments instructed by the Engineer up to 95 per cent of the designed ultimate load. This load shall be held for 15 minutes without failure of the unit. The deflection at the end of this period shall be not more than 1/40th of the span. The load shall then be further increased until failure occurs.

If the unit fails to sustain the required load for the prescribed period or if the deflection exceeds the specified amount, the Engineer may order two further tests, and if either of these fail, the batch of units which they represent may be rejected.

6.6 Submission of samples

As soon as possible after the contract has been awarded, the Contractor shall submit to the Engineer a list of the suppliers from whom he proposes to purchase the materials necessary for the execution of the Works. Each supplier must be willing to admit the Engineer or his representatives, to his premises during ordinary working hours for the purpose of obtaining samples of the materials in question. Alternatively, if desired by the Engineer, the Contractor shall deliver the samples of the materials to the Engineer's office without charge.

The information regarding the names of the suppliers may be submitted at different times, as may be convenient, but no source of supply shall be changed without the Engineer's prior approval once a supplier, source or material has been approved.

Samples of materials approved will be retained at the Engineer's office until the completion of the contract. Samples may be tested to destruction.

All materials delivered to site must be at least equal in all respects to approved samples, otherwise they shall be rejected. No special payment will be made for compliance with clauses specifying tests etc. to ensure quality control etc. unless specifically itemised in Bills of Quantities.

6.7 Materials for concrete

a) General

The Contractor shall submit to the Engineer full details of all materials which he proposes to use for making concrete. No concrete shall be placed in the Works until the Engineer has approved the materials of which it is composed. Approved materials shall not thereafter be altered or substituted by other materials without the consent of the Engineer.

b) Cement

Cement shall comply with the following Kenya Standards:-

- BS12 for Ordinary Portland cement.
- BS12 for Rapid Hardening Portland cement plus all special conditions to its use stipulated by the manufacturer.
- BS 4027 for Sulphate Resisting or High Alumina cement.

Cement shall be free flowing and free of lumps. It shall be supplied in the manufacturer's sealed unbroken bags or in bulk. Bagged cement shall be transported in vehicles with effective means of ensuring that it is protected from the weather.

Bulk cement shall be transported in vehicles or in containers specially built and equipped for the purpose.

Cement in bags shall be stored in a suitable weatherproof structure of which the interior shall be dry and well ventilated at all times. The floor shall be raised above the surrounding ground level and shall be so constructed that no moisture rises through it.
Each delivery of cement in bags shall be stacked together in one place. The bags shall be closely stacked so as to reduce air circulation but shall not be stacked against an outside wall. If pallets are used, they shall be constructed so that bags are not damaged during handling and stacking. No stack of cement bags shall exceed 3 metres in height. Different types of cement in bags shall be clearly distinguished by visible markings and shall be stored in separate stacks.

Cement from broken bags shall not be used in the Works.

Cement in bags shall be used in the order in which it is delivered.

Bulk cement shall be stored in weatherproof silos which shall bear a clear indication of the type of cement contained in them. Different types of cement shall not be mixed in the same silo.

The Contractor shall provide sufficient storage capacity on site to ensure that his anticipated programme or work is not interrupted due to lack of cement.

Cement which has become hardened or lumpy or fails to comply with the Specification in any way shall be removed from the site.

All cement for any one structure shall be from the same source.

Cement which is stored on site for longer than one month shall be rejected.

c) Fine Aggregate

Fine aggregate shall be clean, hard and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with BS EN 13055, all the material shall pass through a 5mm standard sieve and the grading shall be in accordance with Zones 1, 2 or 3 of BS EN 12620. In order to achieve an acceptable grading, it may be necessary to blend materials from more than one source. Fine aggregate for mortar only shall comply with BS 1199 and BS 1200.

The fine aggregate shall not contain iron pyrites or iron oxides. It shall not contain mica, shale, coal or other laminar, soft or porous materials or organic matter unless the Contractor can show by comparative tests, on finished concrete as set out in BS 8110, that the presence of such materials does not adversely affect the properties of the concrete.

d) Coarse aggregate

Coarse aggregate shall be clean, hard and durable crushed rock, crushed gravel or natural gravel complying with the requirements of BS EN 12620. The material shall not contain any iron pyrites, iron oxides, flaky or laminated material, hollow shells, coal or other soft or porous material, or organic matter unless the Contractor can show by comparative tests on finished concrete as set out in BS EN 12620 that the presence of such materials does not adversely affect the properties of the concrete. The pieces shall be angular, rounded or irregular as defined in BS EN 12620.

Coarse aggregate shall be supplied in the nominal sizes called for in the Contract and shall be graded in accordance with BS8204 for each nominal size.

f) Delivery and storage of aggregates

Aggregates shall be delivered to site in clean and suitable vehicles. Different types or sizes of aggregate shall not be delivered in one vehicle.

Each type or size of aggregate shall be stored in a separate bin or compartment having a base such that contamination of the aggregate is prevented. Dividing walls between bins shall be substantial and continuous so that no mixing of types or sizes occurs.

The storage of aggregates shall be arranged so that as far as possible rapid drying out in hot weather is prevented in order to avoid sudden fluctuations in water content. Storage of fine aggregates shall be arranged so that they can drain sufficiently before use in order to prevent fluctuations in water content of the concrete.

g) Water for concrete and mortar

Sea water or brackish water containing more than 1,000 ppm chloride ion or 2,000 ppm sulphate ion shall not be used for mixing or curing concrete.

Water shall be clean and free from harmful matter and shall comply with the requirements of BS 3148

The Contractor shall carry out tests in accordance with BS 1881 to establish compliance with the Specification.

6.8 Building stone

All building stone shall be capable of withstanding when wet a crushing stress of 1.4 kg./sq.mm. The source of stone shall be approved by the Engineer and stone supplied therefrom shall be free from Magadi, overburden, mudstone, cracks, sandholes, veins, laminations or other imperfections.

The stone shall be chisel dressed into true rectangular blocks, with each surface even and at right angles to all adjoining surfaces, to the size specified. For exposed stonework the maximum permissible variation of any of the specified dimensions shall be 6mm provided that cut stone, supplied as 'rock face' stone may be hammer dressed on one face only, or on one face and one end, if in other respects it conforms with this specification. Stones shorter than 375mm will not be accepted.

Unless the Engineer allows otherwise the Contractor shall at his own expense provide and dress four 100mm cubes of stone for testing.

The stone shall be sound when tested in accordance with BS 5390 except that:-

i) The treatment shall be repeated for 10 cycles only; and
ii) The second criterion of failure shall be amended to allow for a loss of weight of not more than 20% of its original weight.

6.9 Murram

Murram shall be from an approved source quarried so as to exclude vegetable matter, loam, top soil or clay. The California Bearing Ratio of the murram, as determined for a sample compacted to maximum density (as defined under BS 1377) and allowed to soak in water for four days, shall not be less than 30%. This C.B.R. is a guide to quality only and the compaction in the work will be judged by density.

6.10 Cement mortar

Cement mortar shall consist of proportions by volume as specified of Portland cement and natural sand or crushed natural stone or a combination of both as specified in BS 1199 and 1200: Building Sands from Natural Sources. The constituent materials shall be accurately gauged and mixed in an approved manner.

Cement mortar shall be made in small quantities only as and when required, and any mortar which has begun to set or which has been mixed for a period of more than one hour shall be rejected.

6.11 Concrete blocks

Solid and hollow concrete blocks for walling shall comply with BS 8500 in every respect.

All solid and hollow concrete blocks used in the walling must be capable of withstanding a crushing pressure of not less than 0.35 kg per square millimetre after 28 days. The blocks shall be cast in Metric sizes.

7. TESTING OF MATERIALS AND WORKMANSHIP

7.1 Apparatus required for testing on site

Apparatus for testing shall be, if directed by the Engineer, made available on site of the works, for as long a period as required by the Engineer, and regarded as constructional plant. The Contractor to allow for this provision in his rates. The following may be required:-

a) A set of sieves complying with British Standard 410: Test Sieves, or the following nominal sizes:-

Fine mesh wire cloth 200, 100, 72, 52, 36, 25, 18, 14, 10 and 7.

Medium mesh wire cloth 3mm.

Perforated plate 5mm, 6mm, 9mm, 12mm, 20mm, 38mm, 50mm, 65mm and 75mm.

b) A suitable balance, a pycnometer and a stove or other approved apparatus for determining the moisture content of the aggregate. The methods of test shall be as described in Part Four of British Standard 812: Sampling and Testing of Mineral Aggregates, Sands and Fillers.

c) A 200 ml. graduated cylinder in accordance with British Standard 604: Graduate Measuring Cylinders, for the use in the field settling test for clay and fine silt in aggregates.

d) Two 0.34 kg. graduated clear glass medicine bottles for use in the test of organic impurities in sand.

e) Apparatus required for testing soils in accordance with British Standard 1377: Methods of Test for Soil Classification and Compaction, and British Standard 1924: Methods of Test for Stabilised Soils.

f) Apparatus for testing concrete in accordance with British Standard 1881: Methods of Testing Concrete, Parts 1 to 7.

g) A straight edge 3 meters long and measuring wedge or other approved apparatus for testing the accuracy of surfaces.

h) Additional testing equipment as stated in the Bill of Quantities or as required by the Engineer.

7.2 Load testing of pipes

The Engineer may instruct the Contractor to make a Loading Test (Three-Edge Bearing or Sand Bearing) on pipes to be used to construct the sewer. Payment for Load Tests will be entirely in accordance with the General Conditions of Contract.

8. ELECTRICAL-MECHANICAL WORKS

8.1 Electrical Works

8.1.1 Contractor's license

The complete electrical installation shall be carried out by a trained electrician with certificates in electrical works. The certificates have to be approved by the Project Manager before commencement of works.

8.1.2 Regulations and standards

The complete electrical installation shall be carried out as per the Specifications and complying with the following documents: -

a) Electric Power Act and the Rules made thereunder.
b) The Kenya Power & Lighting Co. Ltd.'s Bye-Laws.
c) Relevant current British, Deutsche Industries Norm (DIN), International Standards Organisation and Kenya Standard Specifications and Codes of Practice.
d) Government Electrical Specification GES 1 and 2, which can be seen at the office of Chief Electrical Employer's representative of Ministry of Public Works.

Regulations of 14th Edition of I.E.E. Regulations are in force at present in Kenya and to be observed in conjunction with other related local Byelaws and Acts.

8.1.3 Extent of electrical work within contract

The electrical works in the proposed development are required to be complete in all respects as specified herein and shall include all items of equipment, materials, accessories, switchgear, lighting fittings, cables, labour, etc., necessary whether such items are specifically referred in the Contract or not. The Contractor shall be deemed to have included in his Tender, price for all items necessary such that the installations are complete in all respects and left in a satisfactory working order.

The Contractor will be responsible for liaison with the Kenya Power & Lighting Company Limited and the Kenya Posts & Telecommunications Corporation to suit the incoming power and telephone requirements.

All work and materials are to be of the best quality approved by the Employer's representative and strictly in accordance with the Specification.

8.1.4 Materials

All materials used in the Contract shall comply with the appropriate Standard Specification where such applies.

Conduit fittings shall be the same metal as the conduit to which they are connected except that Zinc-alloy OR Aluminium-alloy fittings may be used with steel conduits.

Conduit fittings and accessories shall conform to the appropriate Standard. Conduits shall be mechanically and electrically continuous.

All bends and sets shall be made cold without altering the section of the conduit. The inner radius of the bend shall not be less than two and a half times the outside diameter of the conduit. Not more than two right angle bends will be permitted without the inter-position of the draw-in box. Where straight runs are installed draw-in boxes shall be provided at distance not exceeding 12m. Tees, elbows or sleeves of either inspection or solid type will not be permitted.

Conduits which terminate in fusegear, distribution boards, adaptable boxes, non-spout switches, trunking, etc., shall be connected thereto by means of screwed sockets and smooth bore brass male bushes.

Where conduits are installed flush in floor slabs or in chases in walls, they shall be held firmly in position by means of substantial pipe hooks driven into wooden plugs. Where conduits are installed on surface they shall be fixed with spacer bar saddles at a distance not exceeding one metre. Conduits shall be installed entirely separate and at least 150mm clear of the hot water and steam pipes and at least 75mm clear of cold water and other services.

The Electrical Contractor shall be responsible to ascertain from site details of reinforced concrete and structural steel work and to check from the Main Contractor's drawings the positions of walls, structural concrete and steel work finishes, etc. No reinforced concrete or steelwork shall be drilled without obtaining permission from the Structural Employer's representative.

All circular conduit boxes shall be of a malleable iron with 50mm fixing centres fitted with H.G. lids where required. They shall be long spouts internally threaded. Deep boxes or extension rings on standard circular boxes shall be used where necessary in order to bring the front face of each box flush with the ceiling or wall.

Conduit boxes installed externally shall be galvanised and where subjected to direct weather conditions they shall be compound filled.

Where the words or other approved or equal are used, they shall mean any make of equal quality but the written approval of the Employer's representative for the use of such alternative shall be obtained prior to their use in the installation. In the absence of any such request, the Employer's representative is entitled to suppose that materials used are specified.

8.1.5 Record drawings

The Contractor shall keep on site at all times a complete set of the drawings relative to this Contract, and as the Contract works are proceeded with, indicate in red colour on such drawings, any variations to the Contract works as executed from those shown on the Contract Drawings. The 'As Built' drawings shall be submitted to the Employer's representative on completion of works or when demanded in writing. A minimum of three sets of 'As Built' drawings shall be provided.

8.1.6 Testing

On completion of the electrical installation work the installation shall be subject to the test as laid down in the I.E.E. Regulations and Electric Power Act in the presence of the Employer's representative or his representative.

The Contract works shall not be considered complete until all testing has been completed to the satisfaction of the Employer's representative and the Record Drawings have been approved as installed and all specified spares have been provided.

The wiring throughout shall be in looping cables from point to point and no tee or other joints shall be permitted. Conductors of the same circuit shall be contained in the same conduit of trunking. At distribution boards, the neutral conductors shall be connected to the neutral bar in the same sequence as the line conductors connected to fuses or circuit breakers so that they can be readily identified.

8.1.7 Completion and inspection certificates

The electrical works will be part of the final payment certificate and therefore subject to the final joint inspection.

8.2 MECHANICAL WORKS

8.2.1 General

The workmanship and materials covered by this section shall include for the supply, installation and commissioning of all mechanical equipment It shall also include submission of shop and working drawings, testing and test connections, and operation manuals as specified.

All materials and equipment shall be obtained from reputable manufacturers, who have well established agent(s) in Kenya. The local agent(s) shall be able to provide an efficient service for the equipment and shall have ample stocks of all expendable items such as fuses, etc.

The Employer's representative reserves the right to reject manufacturer(s) or agent(s) not fulfilling the above requirements.

It is the responsibility of the Contractor to provide evidence that the equipment is in compliance with the Bills of Quantities, Specifications herein, and as shown on the drawings, and that the equipment will operate satisfactorily under the conditions under which it is installed. The work shall comprise complete installation such as anchor bolts, base plates, gaskets, painting, etc., all to the satisfaction of the Employer's representative.

8.2.2 Drawings

The works as shown on the drawings are prepared for tendering purposes only, and it is the Contractor's responsibility to provide promptly, detailed shop drawings of the equipment he proposes to use. It is also the Contractor's responsibility to see that all openings, recesses, channels, conduits, etc., in structures are so located and installed as to fit and function properly with mechanical and electrical works.

The Contractor shall prepare all necessary detailed or workshop drawings required for manufacturing and erecting the equipment. Such drawings shall be submitted to the Employer's representative for approval prior to the commencement of manufacture and installation of the equipment. Upon completion of the works, the Contractor shall prepare and submit information on as-built drawings to the Employer's representative for his retention.

The Contractor shall be responsible for any discrepancies, errors, or omissions in the Contractor's drawings unless they are due to incorrect drawings or other written information supplied by the Employer or the Employer's representative. Approval by the Employer's representative of the Contractor's drawings shall not relieve the Contractor from any responsibility under this section.

8.2.3 Initial defects liability period

During the two months Defects Liability Period, the Contractor shall carry out all necessary adjustments and repairs, cleaning and lubricating, etc., required for maintaining the equipment in good working condition. A report of any work executed with respect to such maintenance shall be submitted to the Employer's representative and incorporated in Maintenance Records.

The Contractor shall bear all the costs required for maintenance and inspection services of the equipment and provide for all labour, tools, instruments and plant, and the transportation thereof, as required for the satisfactory execution of these obligations and for the provision, use and installation of all materials such as fuses, expendable items, oils, greases, etc., and such parts which are periodically renewed as relay contacts or parts which are faulty for any reason.

8.2.4 Manufacturer's maintenance manuals

Upon completion of the works, the Contractor shall furnish to the Employer's representative 1 copy of Manufacturer's Maintenance Manuals for the equipment installed in A-4 size loose leaf type binding containing information on the following items:

a. Description of Equipment
b. Full Operation and Maintenance Instructions
c. Valve Operations
d. Maintenance and Service Periods
e. Lubricating Instructions
f. Colour Code Legend
g. Spares List
h. Record Drawings in size A-4 / A-3
i. Any other relevant information.

All instructions in the Manual shall be written with reference to the drawings. All valves, terminals and controls in the plant and other sites be labelled to correspond with the Operation and Maintenance Manual.

The Works will not be considered completed for the purpose of taking over until such Manual containing instructions and the drawings have been supplied to the Employer.

All costs arising to comply with this Clause is deemed to be covered in the Contractor's rates.

9. MISCELLANEOUS

9.1 Galvanized work

Iron and steel, where galvanised, shall comply with B.S. 729, entirely coated with zinc after fabrication by complete immersion in a zinc bath in one operation and all excess carefully removed. The finished surface shall be clean and uniform.

9.2 Pressed steel tanks and towers

The pressed steel tanks (or similar approved), towers and associated materials and fittings shall comply with BS 1564.

Detailed drawings of the steel tank should be submitted to the Engineer for approval prior to acceptance.

The pressed steel tank to B.S. 1564 Type A(2) or similar approved shall be supplied complete with:-

a) All stays, cleats, bolts, nuts, washers, jointing compound and associated materials and fittings.

b) Connections for inlet, outlet, washout and overflow.

c) Galvanised access ladder 450mm wide.

d) Steel roof cover to fit the tank complete with access manhole and mosquito-proof cowl ventilators.

e) Water level indicator.

Jointing material to the tank to be a non-toxic plastic compound which does not impart taste, colour nor odour to the water.

Connections to the tank shall be welded to the outside of the tank plate and drilled and tapped to suit unless otherwise stated.

The cover to the tank shall be of mild steel cambered for external use and adequately supported by rolled steel or pressed steel bearers or trusses.

The tank tower shall be supplied complete with:-

a) Anchor bolts.

b) Bolts, nuts, washers and associated materials and fittings.

c) Access ladder 450mm wide extending from ground level to the top of the tank. Safety rings shall be at 1.2m centres.

The supports to the tank shall consist of steel joints designed to carry imposed load under each transverse joint and the two ends of the tank.

The columns of the tank shall consist of rolled steel joist sections or similar. Four or more such columns shall be provided with adequate bracing.

Internal surfaces of the tank shall be painted with approved non-toxic primer and non-toxic bituminous paint.

External surfaces of the tank and tower shall be painted with approved primer and approved bituminous aluminium paint.

9.3 Paint and painting

All paint, including primers, undercoats and finishing, polish, emulsion etc., to be used shall be obtained ready for use from the manufacturer approved by the Engineer.

The Contractor shall order direct from the manufacturer and only fresh paint will be allowed to be used.

All paints shall be of the qualities, i.e. exterior, interior etc., types and colours scheduled. All coats of paint system shall be obtained from the same manufacturer, shall be ordered for use together and as far as practicable, shall be ordered on one order in sufficient quantity for the whole of the work, particularly in the case of the finishing colour. Where more than one of the three systems (gloss, semi-gloss or flat) is in use, these paints shall be used in strict accordance with their accompanying printed instructions.

The Contractor shall use only paints delivered to the site in original sealed containers, not exceeding five liter capacity, stamped and bearing the manufacturer's name of mark, the specification number, method of application (e.g. brushing) colour, quantity, batch number and date of manufacture, and expiry.

Contractor's stocks shall not be accepted unless expressly approved by the Engineer's Representative.

The paint, which will be subject to sampling and testing, shall be used exactly as received, after adequate stirring, without the addition of thinners, driers, or adulterating materials of any kind.

All tints and shades (including colours of undercoats) shall be selected and approved by the Engineer's Representative and the Contractor shall allow in his prices for executing the painting work in colour schemes, to be prepared from a wide range of colours.

All paints described as oil paint shall be alkyd paint.

No painting on exterior work shall be carried out in wet weather or upon surfaces which are not thoroughly dry. Painting shall not proceed in dusty conditions. Each coat of paint shall be thoroughly dry and shall be rubbed down with glass paper before a subsequent coat is applied. Adequate care must be taken to protect surfaces of paintwork, still wet.

Lead based priming paints for steelwork shall conform to B.S. 2521 and 2523.