



REPUBLIC OF KENYA

MINISTRY OF WATER, SANITATION AND IRRIGATION



TANATHI WATER WORKS DEVELOPMENT AGENCY

TECHNICAL SPECIFICATIONS

TENDER No. TAWWDA/003/2023-2024

EXPANSION AND AUGMENTATION OF MASINGA KITUI INTAKE
WORKS PROJECT

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1. GENERAL

1.1. Introduction

These Special Specifications cover the Expansion and Augmentation of Masinga Kitui Intake Works Project, located in Masinga, Machakos County, as shown on the drawings and listed in the Bills of Quantities and shall be read in conjunction with the Contract Documents as listed in Volume 1, Instruction to Tenderers.

1.1.1. Location and Extent of Site

The project is a for water supply for the areas of Kitui and Machakos counties. The project is envisaged to construct an intake for Kitui and rehabilitate the existing intake & water treatment system to boots supply of water to Kitui and Machakos counties. The current dam with gross storage capacity 1.56 billion m³ which provides water to a conventional water treatment plant with 9,000 m³/day capacity to serve Kitui and Machakos counties and their environs.

1.2. Extent of Contract

The works specified under this contract shall include all general works, preparatory to the construction of the works and materials and work of any kind necessary for the due and satisfactory construction, completion and maintenance of the works to the extent as shown on the drawings and these specifications and any other instructions that may be issued by the Engineer from time to time whether specifically mentioned or not in the clauses of this specification.

1.3. Contract Drawings

Two sets of full sized drawings will be issued to the Contractor, at the commencement of the Contract to facilitate the construction of the Works in complete conformity with and to the full intent of the Contract. Additional copies of these drawings that may be required by the Contractor can be obtained from the Engineer, in which case the Contractor will be required to reimburse the cost of producing such additional copies.

The Engineer may from time to time in order to enable the satisfactory completion of the Works, revise, amend, or supersede any of these drawings. It shall be the Contractor's responsibility to construct all Works in conformity with the latest revision, amendment or superseding drawings, provided that the Engineer has given to the Contractor in writing such reasonable prior notices of intention to revise, amend or supersede as the nature of the intended change requires and the relevant drawings have been issued to the Contractor.

The Contractor may be required to demolish, alter and/or correctly rebuild at his own expense any part of the Works not in conformity with the drawings currently forming part of the Contract at the time of construction of such Works, provided always that such current drawings had previously been issued to him.

1.4. Standards

In the Specifications, Bills of Quantities, and Drawings reference has been made to relevant British Standard Specifications and Codes of Practice - to which the materials and workmanship should comply with. However, the materials and workmanship complying with equivalent Kenya Bureau of Standards (KE.B.S.) or International Standards Organisation (ISO.), for that particular material or workmanship will also be acceptable.

Mixture of different Standards in one trade will not be allowed. Standard, then all the pipes for the works are to be to ISO standard.

The Contractor may propose that the materials and workmanship be defined in accordance with the requirements of other equivalent Standards and the Contractor may execute the works in accordance with such other Standards as may be approved by the Engineer, A copy of the Standard, together with its translation into the English language if the Standard is in another language, shall be submitted to the Engineer with any request that it be adopted.

Where the dimension in one standard does not completely correspond to the dimension of the other standard, which is being used for construction of works, ruling of the Engineer will be sought and any decision given by the Engineer will be final and binding upon the Contractor.

1.5. Programme of the Execution of Works

In accordance with Sub clause 9.3 of the conditions of contract, the Contractor upon receiving Engineer's order to commence shall within 28 days draw up a working programme setting out order and method in which the works are to be carried out with appropriate dates thereof, together with delivery dates for materials. The Contractor shall together with his work programme supply an expenditure chart showing monthly anticipated expenditure.

If at any time it should appear to the Engineer that the actual progress of then Works does not conform to the programme referred to above, the Contractor shall produce, at the request of the Engineer, a revised programme showing the modifications to the approved programme necessary to ensure completion of the Works within the time for completion as defined in sub clause 9.2 of the Conditions of Contract.

In addition the Contractor shall extract from the main program and provide a 90 days program showing works he intends to execute within every 90 day period and submit the program within the first week of each quarter.

The programme shall be deemed to have taken into account normal variations in climatic conditions to provide for completion of the works in the order and within the times specified therein.

The various operations pertaining to the Works shall be carried out in such a progressive sequence as well as will achieve a continuous and consecutive output of fully complete pipeline works inclusive of all appurtenances, treatment plants and all installations within the time limits specified in the Contract. Generally, the Contractor shall progress continuously without leaving any isolated section incomplete, provided that the land upon which the works are to be constructed has been acquired in the entirety and the encumbrances and services thereon removed.

The Contractor shall carry out the Contract in accordance with the programme agreed with the Engineer, but he shall in no manner be relieved by the Engineer's approval of the programme of his obligations to complete the Works in the prescribed order and by the prescribed completion date and he shall from time to time review his progress and make such amendment to his rate of executions of the works as may be necessary to fulfil these obligations.

Once the proposed programme is approved by the Engineer the Contractor shall not depart from the programme without the written consent of the Engineer. In the event of unforeseen difficulties or disturbances arising, which force the Contractor to depart from the approved Programme of Works, he shall advise the Engineer in writing of such occurrences without delay and submit proposals for any necessary remedial measures, for which he shall obtain the Engineer's approval before putting such measures into effect.

1.6. Substantial (Practical) Completion

Substantial or Practical Completion of Works is to be understood as a state of completion, which leaves out only minor outstanding items that can be readily completed within a period of less than 1 month without interfering with the normal operation of the Works.

The works will not be considered as substantially or practically completed without the works being capable of being used by the Employer in accordance with the purpose of the works.

1.7. Method of Construction

The Contractor shall submit to the Engineer not later than 28 days from the date of award of the Contract a general description of his proposed arrangement and method for execution of the works, including inter alia temporary offices, buildings, access roads, deviations, constructional plants and its intended production output, working shift arrangements, power arrangements, supply of materials, stone crushing, aggregates production and storage, cement handling, pipe handling and storage, Concrete mixing and handling, method of excavation, dealing with water, testing methods and facilities.

During execution of the works, the Contractor shall also submit to the engineer full and detailed particulars of any proposed amendments to the arrangement and method submitted in accordance with the foregoing.

The Engineer's Normal working hours shall be Monday to Friday 8.00 a.m. to 5.00 p.m. and Saturday 8am to 1pm. with all Public Holidays set aside as required. If the Contractor wishes to execute permanent works outside these hours, he shall obtain a written permission of the Engineer at least one full working day in advance to enable the engineer

to make provision for supervision of such work.

1.8. Notice of Operations

No operation shall be carried out without full and complete notice having been given to the Engineer by the Contractor sufficiently in advance of the time of the operation to enable the Engineer to make arrangements as he may deem necessary for its inspection and checking.

The Contractor shall give the Engineer not less than 1 full working days' notice in writing of his intention to set out or give levels for any part of the works in order that arrangements may be made for checking.

1.9. Nominated Sub-Contractors and Nominated Suppliers

The Contractor shall be responsible for Nominated Sub-Contractors in every respect. In particular it shall be the Contractor's responsibility to ensure that each Sub-Contractor commences and completes the work in a manner so as to conform to the working programme, as specified above.

Sub-Contractors and Suppliers in the project area shall be given preference in subcontracts as far as they meet the requirements for such sub-contracts.

It is also the responsibility of the contractor to ensure a satisfactory progress of the works and to ensure that the works are completed to a standard satisfactory to the Engineer.

The Contractor shall accept liability for and bear the cost of General and Specified Attendance on Nominated Sub-contractors which shall be deemed to include for:-

- (i) Allowing the use of standing scaffolding, providing special scaffolding, maintenance and alteration of all scaffolding, retention of all scaffolding until such time as all relevant Sub-Contractor's works are complete and removal of all scaffolding on completion.
- (ii) Providing equipment and labour for unloading and hoisting Sub-Contractor's materials.
- (iii) Providing space for office accommodation, and for storage of plant and materials: allowing use of sanitary accommodation; the supply of all necessary water, power, lighting and watching and clearing away all rubbish.

Before placing any orders with nominated Sub-Contractors or nominated Suppliers, the Contractor should enter into an agreement with the nominated Sub-Contractor /nominated Suppliers to ensure that the conditions and delivery of materials to site comply with the Conditions of Contract and the working programme.

Particular clause should be inserted in the agreement with the nominated Suppliers ensuring the validity of the rates for the supply of materials as per the delivery schedule.

Nominated Suppliers who are unable to meet the delivery schedule will not be given allowance for any increases in prices incurred after the delivery time agreed in the delivery schedule.

1.10. Entry upon Land, Working Site and Adjoining Lands

The Employer shall provide land, right-of-ways and way-leaves for the Permanent Works specified in the contract only.

The Employer shall make available free of charge to the Contractor all land on, under or through which the permanent works are to be executed or carried out all as indicated in the book Drawings or as detailed in the Specifications. Such land shall exclude land required by the Contractor for his own camps, Borrow sites, offices, houses, temporary works or any other purpose.

The Contractor shall give notice to the Engineer at least 30 days before he wishes to enter on to the land required to carry out the permanent works under the Contract. The Contractor shall not enter on to any land or commence any operations until such time as he receives formal confirmation from the Engineer that all necessary compensation formalities have been completed and that permission has been obtained from the land owner to enter the land and commence operations. Should the Contractor enter on to any land and commence operations without first obtaining this confirmation, he shall be liable in whole or in part, at the sole discretion of the Engineer, for all additional costs and/or

legal charges which might arise there-from.

The Contractor shall on his own accord obtain rights of admission, and rights of using all other areas which are necessary for storing and manufacturing or for setting up site offices and Resident Engineer's office or whatsoever will be necessary including borrow sites. No separate payment will be made to the Contractor on account of these items and the Contractor must make due allowance for them in his rates.

The Contractor shall take care to prevent injury, damage and trespass on lands, fences and other properties near and adjacent to the works and must in this connection make all necessary arrangements with adjoining landowners, or in the case of Government Property with officers appointed for this purpose, and ensure the workmen's observance of all Government rules and Ordinances regarding game protection and other matters and provide, maintain and clear away on completion of the Works all temporary fencing which may be required for execution of the Works.

Before completion of the Works the Contractor must make good or compensate any such injury, damage or trespass on lands, fences and other properties which have not otherwise been provided for in the Contract.

1.11. Preservation of Survey Beacons

Ordinance Survey Beacons, Benchmarks, etc., on or around the site of the Works shall not be disturbed unless permission has been obtained by the Engineer from the Survey of Kenya.

In the event of unauthorized disturbance of such beacons, benchmarks, etc., in the course of the Works being carried out the Contractor shall be responsible for reporting same to the Engineer and the Survey of Kenya and for payment of any fees due to said Survey of Kenya for replacement of such disturbed beacons, bench marks, etc. The Contractor shall not replace such disturbed beacons benchmarks, etc. on his own accord.

1.12. Relocation of Existing Services

Drains, pipes, cables and similar services encountered in the course of the Works shall be guarded from damage by the Contractor at his own costs to safe guard a continued uninterrupted use to the satisfaction of the owners thereof, and the Contractor shall not store materials or otherwise occupy any part of the site in a manner likely to hinder the operation of such services.

If the interests of the Works shall, in the opinion of the Engineer, so require, the Contractor shall on the Engineer's direction arrange for the construction of permanent or temporary diversions of the said drains etc., together with reinstatement, if temporary, by the respective Department, Bodies, Corporations or Authorities and, the cost of such works or diversions including reinstatement shall be charged against the appropriate Provisional Sum provided in the Bills of Quantities.

It is the responsibility of the Contractor to inform the Engineer immediately any existing service is exposed.

1.13. Damage to Existing Services

The Contractor shall be held liable for all damage and interference to mains and pipes, to electric cables or lines of any kind either above or below ground caused by him or his Sub-contractors in execution of the Works, whether such services are located on the Contract Drawings or not. The Contractor must make good or report to the appropriate authorities the same without delay and do any further work considered by the Engineer or owner.

If the Contractor fails to reinstate the damaged services within the time considered as reasonable by the Engineer's Representative, then the Engineer's Representative shall be empowered to get the damaged services reinstated by any other contractor and charges thereof shall be deducted from any money due to the Contractor.

1.14. Temporary Roads and Traffic Control

The Contractor shall provide and maintain all temporary roads, bridges and other works to maintain free and efficient access to services affected by Construction of permanent works, the cost of necessary temporary traffic control signs, barricades, beacons, flagmen, lighting and watching required for the normal control of traffic. No payment shall be made for compliance of this item.

1.15. Use of Public Roads

Where a road used by the Contractor for delivery of any material used in the works is closed under Section 71 of the Traffic Ordinance Act 1962, the Contractor shall obey such closure order and use alternative roads.

The Contractor shall keep all roads used by his equipment and project vehicles in well maintained condition including watering and periodic grading/ gravelling as may be instructed by the Engineer from time to time. The items shall be provided in the Bills of quantities and the rate shall include watering, periodic grading, temporarily traffic control, traffic signs, barricades, flagmen, lighting and watching required for control of normal control of traffic.

1.16. Road and Railway Crossing and Traffic Control

Wherever the water pipeline is crossing the classified roads and railway line the Contractor will contact the relevant authorities well in advance and obtain necessary permission to dig across the road and railway line in accordance with requirement of the authorities concerned and shall pay any royalties connected with this work, and the Contractor will provide temporary detour road together with any warning signs necessary. There will be no separate payment for this and cost of all expenses connected with road and railway crossing for which no separate items have been included in Bills of Quantities is deemed to have been covered by the unit rates included in the Bills of Quantities.

1.17. Protection from Water

Unless otherwise mentioned the Contractor shall keep the whole of the Works free from water and allow in his rates for all dams, coffer dams, pumping, piling, shoring, temporary drains, sumps, etc. necessary for this purpose and shall make good at his own costs all damage caused thereby.

1.18. Weather Conditions

The Contractor shall be deemed to take into account all normal weather conditions when preparing his tender and he shall not be entitled for extra payment by the reason of the occurrence or effect of high winds, excessive rainfall, temperature or any other meteorological phenomena occurring during normal seasons in Kenya.

1.19. Protection from Weather

All materials shall be stored on site in a manner approved by the Engineer's Representative and the Contractor shall carefully protect from the weather all works and materials which may be affected thereby.

No separate payment will be made for this and the Contractor will allow in his rates for this.

1.20. Explosives and Blasting

For works requiring the use of explosives, the Contractor shall employ men experienced in blasting, and these men must be in possession of a current blasting certificate. The purchase, transport, storage and use of explosives shall be carried out in accordance with the most recent explosives Ordinance and Rules issued by the Government of Kenya and the Contractor shall allow in his rates for excavation and quarrying for all expenses incurred in meeting these requirements, including the provision of suitable stores. Blasting operations shall be carried out with as little interference as possible to traffic or persons.

In all cases permission from the Engineer must be obtained before commencing any blasting operation. Such approval shall not relieve the Contractor from his responsibility for the damage of the works and adjoining or adjacent structures, roads, places and things, injury, loss, inconveniences and accidents to persons, animals and property consequent on the use of such explosives. The Contractor shall be entirely liable for any accident which shall occur and shall save the employer harmless and indemnified from all claims arising therefrom.

If, in the opinion of the Engineer, blasting would be dangerous to persons or property, or it is carried out in a reckless manner, the Engineer can prohibit any further use of explosives without entitling the Contractor to any extension of time occasioned by corresponding delays.

1.21. Liaison with Police and Labour office

The Contractor shall keep himself in close contact with the Police, Labour Officers and

other officials of the areas concerned regarding their requirements in the control of workmen, passage through townships, or other matters and shall provide all assistance and/or facilities which may be required by such officials in execution of their duties in connection with the Works.

Any instruction given by the Traffic Police concerning fencing off of open trenches or other excavations must be followed explicitly.

1.22. Provision of Water

The Contractor shall provide water for use in the Works. He shall supply all hydrants, hose, cocks, vessels and appliances necessary for the distribution thereof and shall provide pumps, tanks, carts, vessels and appliances, transport and labour when and wherever it is necessary for water to be carted for use at the Works. All water used in connection with the Works shall if possible be obtained from a public water supply and the Contractor shall make all necessary arrangements and pay all the charges for connections to main and for water used. No separate payment will be made for this and the Contractor will allow in his rates for this.

1.23. Temporary Lighting and Power

The Contractor shall provide all artificial lighting and power for use on the Works, including all Sub-Contractors' and Specialists' requirements and including all temporary connections, wiring, fittings, etc., and clear away on completion. The Contractor shall pay all fees and charges and obtain all permits in connection therewith. No separate payment will be made for this and the Contractor will allow in his rates for this.

1.24. Sanitation

The Medical Officer of Health or other Sanitary Authority shall be informed when Works are about to commence. The instructions of the Medical Officer or other Sanitary Authority shall be complied with by the Contractor at his own expense.

The site shall be kept in a clean and proper sanitary condition. No nuisance shall be committed on or around the work, and latrines for the workmen and staff shall be provided in accordance with the requirements of the Medical Officer or Sanitary Authorities. The Contractor shall be responsible for the sanitary discipline of his labour.

The Engineer's Representative has the right to order any labourer, who in the opinion of the Engineer's Representative does not have a satisfactory sanitary discipline, off the site with immediate effect.

The Contractor shall follow the safety rules set down by the Factories Inspectorate, Ministry of Labour. No separate payment will be made for this and the Contractor will allow in his rates for this.

1.24.1. Safety Officer

Contractor's attention is drawn to Legal Notice No. 79 of 22nd September 1978 by which it is mandatory that every Contractor employing more than twenty people should appoint (in writing) a safety supervisor. A safety supervisor advises the management on all matters regarding safety, hygiene and welfare of the people affected by the Contractor's undertaking on the site. The safety officer may in addition carry out other duties.

The contractor shall provide adequate first-aid equipment on the site, and ensure that at least four of his site staffs are competently trained in first-aid. No separate payment will be made for this and the Contractor will allow in his rates for this.

1.24.2. Signboards

The sign board shall be made of 50X50 RHS frame and steel plates, dimensions as directed by the engineer. The sign board shall contain information not limited to: Name of Client, name of engineer's representative, funding agency, asset owner, contractor and title of the project

The Contractor shall erect signboards as shall be directed in prominent positions adjacent to the Works to the satisfaction of the Engineer.

1.24.3. Setting Out

The Contractor must, before commencing any construction work, make sure that levels shown in the drawings correspond with levels found on the site.

Should any discrepancy be discovered between the levels shown on the drawings and

those found on the site, which may affect the levels and dimensions of any part of the Works, the Contractor shall notify the Engineer, who, if necessary, will issue drawings showing the amended levels and dimensions.

The Contractor shall clear the site and set out the Works well in advance to enable the Engineer to inspect and approve the setting out prior to commencement of the Works. The Contractor shall amend at his own cost any error due to inaccurate setting out.

Any checking or approval by the Engineer of the setting out, benchmarks, plans or schedules will not relieve the Contractor of his responsibilities under the Contract.

The Contractor shall provide a site plan showing the position of his site offices, storage sheds, accommodation, Engineer's Representative's office etc., in relation to the permanent works for the approval of the Engineer before commencing erection of his camp.

After completion of the setting out and site clearance, the Contractor shall take ground cross sections along the pipeline at 25m interval and along the centreline of all structures. These shall be plotted in A3 paper, agreed and signed by the Engineer's Representative and Contractor prior to commencement of any excavation works and shall be used for measurement.

1.24.4. Backfilling of Holes and Trenching for Temporary Works

The Contractor shall immediately upon approval of any work at his own expense and to the satisfaction of the Engineer backfill all holes, trenches and temporary quarries which have been made, level all mounds or heaps of earth that may have been raised or made and clear away all rubbish caused by the execution of the work. The Contractor shall bear and pay all costs, charges, damages, and expenses of any kind whatsoever which may occur by reason of holes and trenches connected with the Works or materials or tools or plant being left or placed in improper situation.

1.24.5. Inspection of Works

No part of the Works shall be built in or covered over until it has been inspected and approved by the Engineer and the Contractor must give due notice in writing to the Engineer's Representative when any part of the Works are ready for inspection.

1.24.6. Joint Measurements

All measurements shall be taken jointly by the Contractor and the Engineer as and when the latter so directs and shall be made in accordance with the Specification and Preamble to Bills of Quantities notwithstanding local or other customs.

1.24.7. Cleaning up of Site

The Contractor shall keep the site clean during the entire contract performance period. And before final acceptance upon the completion of the Works the Contractor shall, at his own expense, remove and dispose of all rubbish and remove all equipment, surplus materials, camps and buildings, which the Contractor has provided, and temporary works ordered by the Engineer and shall leave the Site absolutely clear thereof and in good order and condition to the entire satisfaction of the Engineer.

1.24.8. Testing of Water-Retaining Structures

All water-retaining structures shall on completion be tested for water-tightness in the following manner. The structure shall be filled with potable water in stages and held at each stage for such time as the Engineer may require. Should any dampness or leakage occur at any stage the water shall be drained off and the defects made good. The procedure shall be continued and finally the structure shall after a period allowed for absorption remain full for seven days. Within those seven days the level of the surface of the water should be recorded and measurements made at intervals of 24 hours. The total leak must not exceed 0.3% of the total volume of water in the tested structure.

If the structure does not satisfy the conditions of the test, and the daily drop in water level is decreasing, the period of test may be extended for a further 7 days, and, if the specified limit is then not exceeded, the structure may be considered as satisfactory.

Should any dampness or leakages or other defects occur they shall be made good and the structures re-tested until the water-tightness is approved by the Engineer.

Faces of submerged structures may not be covered before testing.

The Contractor shall allow in his rates for all expense and shall provide water and all necessary labour and materials for testing the structure.

1.24.9. Testing of Roofs

Where structures are used for the storage of potable water, adequate precautions should be taken to ensure that the roof is watertight in order to give protection against a potential source of pollution.

The roof should be tested by lagooning the concrete slab to a minimum depth of 75mm for a period of 3 days; the roof slab should be regarded as satisfactory if no damp patches occur on the soffit. The roof screed should be completed immediately after testing.

All water, labour and materials for the test are to be provided by the Contractor who shall allow for this in his rates.

1.24.10. Cleaning and Sterilising Water-Retaining Structures

The interior of all potable water-retaining structures shall be thoroughly cleaned and washed after the water-tightness test has been approved by the Engineer in order to remove all contamination.

The structure shall then be filled to overflow level with clean water containing 50 parts per million of chlorine and left for a period of at least 24 hours. The chlorinated water shall then be drained away and the structures refilled with clear water from which samples shall be taken for bacteriological examination and for tests of residual chlorine. If any of the results of the tests are unsatisfactory when compared with those of the control sample of the supply water the sterilizing process shall be repeated until the results of the tests are satisfactory.

The Contractor shall allow for in his rates: providing water, all labour, materials, chemicals and other things necessary for cleaning and sterilizing the water-retaining structures.

1.24.11. Sampling and analysis of Clean Water in the System

The costs of the initial sampling, analyses and preparing reports on the bacteriological quality of the water shall be borne by the Employer, but should the initial reports be unsatisfactory the costs of any subsequent sampling analyses and preparing reports shall be borne by the Contractor.

1.24.12. Contractor's Superintendence

The Contractor shall give or provide all necessary superintendence during the execution of the Works and as long thereafter as the Engineer may consider necessary for the proper fulfilling of the Contractor's obligations under the Contract. The Contractor or his competent and authorized Agent or Representative approved in writing by the Engineer (which approval may at any time be withdrawn) is to be constantly on the Works and shall give his whole time to the superintendence of the same. If such approval shall be withdrawn by the Engineer, the Contractor shall after receiving written notice or such withdrawal; remove the Agent from the Site within the time stated in the notice and shall replace him by another Agent approved by the Engineer.

1.24.13. Transport of Workmen

The Contractor shall include in his rates for all transport of staff and workmen to and from and in connection with the various parts of the Works, and all costs incurred in recruiting and transporting labour to the site, where such labour is from outlying areas and costs of returning labour on termination of the Contract.

1.24.14. Normal Working Hours

These shall be taken as Monday to Friday 8.00 a.m. to 5.00 p.m. and Saturday 8am to 1pm. with all Public Holidays set aside as required. The Contractor shall allow for observance of Sabbath or any other religious days to his staff.

Where the Contractor wishes to work outside these hours he shall request the Engineer in writing at least 24 hours in advance for consideration. The Contractor shall bear the cost of overtime for all Engineer's support staff associated with such works.

1.24.15. Accommodation for Contractor's Workmen

The Contractor shall provide and maintain suitable shelters and mess facilities for his

workmen and supervisory staff. The facilities shall be of sufficient size and to a standard considered satisfactory by the Engineer.

The Contractor shall throughout the contract provide an adequate supply of potable water for the Workmen.

1.24.16. Storage Space: Sheds

Suitable temporary stores and workshops shall be erected and later removed on completion of the works. All buildings shall be adequate for protection of the equipment of materials to be kept therein and shall be constructed and located to the satisfaction of the engineer.

1.24.17. Office for the Contractor

The Contractor shall erect an office near the Works on a site to be approved by the Engineer. This office shall be kept open at all hours during which the work is in progress.

Any notice to be given to or served upon the Contractor shall be deemed and taken to be effectively given or served upon by the delivery thereof at such office on the Site.

1.24.18. Communication

The Contractor shall, if so instructed by the Engineer, provide mobile phones and airtime as necessary for the duration of the contract and, VSAT internet connection, post office, courier, radio communication for the exclusive use of the Engineer. The model and make of the mobile phones shall be approved by the Engineer.

Failure by the Contractor to provide or maintain the same shall make him responsible for all costs that may be incurred as a result of the Engineer's staff using alternative means of communication, including delays in supervision and approval of the works.

Payment for complying with this requirement is included in the bill of quantities.

1.24.19. Houses, Office, Laboratories for the Engineer's Staff and Time for erection

The Contractor shall provide and maintain houses, offices, laboratories, survey and laboratory equipment and furniture for the Engineer and his staff including senior staff, junior staff and technicians

All houses, offices and laboratories to be provided under the contract shall be handed over to the engineer in finished and fully habitable condition not later than sixty days
(Conditions of Contract)

No construction of the any works will be permitted until the engineers offices and laboratories have been accepted by the engineer as finished and able to function efficiently.

Should the Contractor fail to hand over the houses, offices, and laboratories within the period specified, the engineer will make such arrangements as he considers necessary. These arrangements may include use of hotels, rented accommodation, and the hire or purchase of caravans, port-cabins etc. the contractor will be responsible for all costs of such temporary arrangements made by the engineer, including that of additional cost of transport.

Any delays to the Contractor or the Contractor's activities caused by the Engineer being unable to perform survey work, field or laboratory tests due to the Contractor's failure to supply and/or maintain the said equipment, houses and accommodation shall be deemed to have been caused by the Contractor's own actions, and any consequences of such delays shall be interpreted as such.

1.24.20. Housing Accommodation for the Engineer's Senior Staff

The Contractor shall construct, equip and maintain houses (Two for type I and Five for type II or equivalent) for the Engineer's senior staff. The Engineer's senior staff houses shall be separate from that of the Contractor's staff housing and shall be sited and constructed to the satisfaction of the Engineer as detailed in the Drawings. Contractor to provide equivalent temporary accommodation during the construction of these units.

Type I and II Houses shall be in accordance with the book of drawings, and shall be constructed with material to be approved by the Engineer. The Engineer shall approve the design and construction of the same. These houses shall revert to the Client at the end of the project. They shall be paid for in accordance with Clause 1.51 of this Specification, under Bill items 1A219 of the Bill of Quantities.

All material used shall be new, strong, durable and weatherproof. Ceilings and floor must be properly insulated against heat with approved insulated material. The floor shall have a level smooth finish. All windows shall be glass, able to be opened, and with mosquito nets. The building materials shall be mosquito and termite proofed and painted in and outside with two coats of paint/ varnish, all to the approval of the Engineer.

The ceilings of houses and verandas shall be lined with ceiling board. All doors are to be fitted with mortise locks, which must be heavy duty on external doors. All windows shall be fitted with burglar bars.

The roof cladding shall be with G.I. corrugated sheets or equivalent material. The lounge, bedroom, bathroom, toilet and kitchen floor will have cement mortar finish floors. The workbenches in kitchen shall have approved cover. All the sanitary ware shall be vitreous China or equivalent of approved quality.

All houses are to be provided with a fire extinguisher and fire axe. Fire axes are to be secured to the outside of the buildings.

All storerooms shall be fitted with at least 3 substantial shelves and kitchens shall be fitted with shelves, drawers and cupboards as instructed.

The Contractor shall provide new furniture, equipment and fittings as listed herein below. The Contractor should obtain approval of the Engineer for the type and quality of the furniture, fittings and equipment before ordering.

All houses shall be provided with a piped supply of drinkable water, electricity, gas and kerosene for the consumption of the Engineer and his staff and the Contractor shall provide all necessary waterborne sanitation and disposal systems to the satisfaction of the Engineer.

The Contractor shall pay for water, electricity, gas and kerosene consumed, and for the statutory charges associated therewith. The Contractor shall be responsible for rubbish disposal by providing outside bins and daily collection to a central area located to the satisfaction of the Engineer.

Each type I and II house shall be erected separately. A barbed wire topped chain link wire fence 2 metres high with a chain and padlock lockable gate shall be provided around the general perimeter of the types I and II houses.

Each type I and II house shall be provided with day and night watchmen and security lights, the cost of which shall be deemed to have been included in the rates for the houses.

This senior staff will generally comprise the following:

<u>Designation</u>	<u>Number</u>
Resident Engineer	1
Materials Engineer	1
Engineering Surveyor	1
Assistant Resident Engineer Structures	1
Assistant Resident Engineer Water	1
Assistant Resident Engineer Electro-Mech.	1
Health and Environmental Officer	1

1.24.21. Housing Accommodation for Engineer's Junior Staff

The Contractor shall construct, equip, furnish and maintain 16 No. Type II or equivalent for the Engineer's Junior staff, to be located adjacent to Resident Engineer's offices and laboratory, the location of which will be subject to Engineer's approval.

Additional junior staff houses shall be temporary and made in durable and weatherproof materials and to a similar standard as the senior staff houses.

The additional junior staff housing including furniture and fittings shall all revert to the Contractor on completion of contract. They shall be paid for in accordance with Clause 1.51 of this Specification This staff will generally comprise the following:

<u>Designation</u>	<u>Number</u>
Surveyor	2
Draftsman	1
Senior Lab Technician	1
Administration Assistant	1

Draughtsman	1
Secretary	1
Assistant Surveyor	2
Assistant Draughtsman	1
Inspector	6
Lab Technician	4
Leveller	2

1.24.21.1.1. Engineer's Offices

The Contractor shall construct and maintain for the duration of the Contract, a furnished and equipped main office for the Engineer's Representative of durable and weather-proof construction, provided with mosquito-proof and burglar-proof windows and lockable doors and suitably insulated against heat and cold, all to the satisfaction of the Engineer in respect of the construction, design and sitting. The office shall comply with the details shown in the drawings and shall have a clear height of not less than 2.6 m. The floor shall be of floated concrete, and adequately damp- and termite-proof.

A telephone shall also be provided for the Resident Engineer's office for his exclusive use. The Contractor shall be responsible for paying all the charges and fees related to the use of the telephone and be reimbursed the same on production of proof of payment.

The office for the Engineer's Representative shall be completely separate from that of the Contractor and shall be fenced with a 2m high chain linked fence and gate with padlock and chain.

Toilets and washrooms graded to staff seniority, together with drinkable water supply and water borne sewage disposal, shall be provided for the office. The Contractor shall also provide 24 hours a day electricity supply to the offices and shall allow for any water and electricity consumed and for any statutory charges associated.

Unless the offices are accessible via an existing paved road the Contractor shall also provide an access road at least 4m wide to the office. A 100 square meters covered car parking area. Both access road and car park shall be surfaced with at least 150 mm of consolidated gravel properly graded, cambered, drained and culverted.

The offices shall be provided with day and night watchmen and security lights, the cost of which shall be deemed to have been included in the rates for the offices.

1.24.21.1.2. Laboratory

The Contractor shall construct, and maintain for the duration of the Contract, a laboratory complying with details shown on the standard drawing or equivalent, to the satisfaction of the Engineer. The building shall be of durable and weatherproof materials, provided with mosquito-proof and burglar proof windows and lockable doors, and suitably insulated. The laboratory shall be sited adjacent to the Resident Engineer's main office.

The laboratory shall have piped potable water supply and a continuous electricity supply adequate for lighting, heating and operating the laboratory equipment.

The laboratory shall have a height from floor to ceiling of not less than 2.75 metres and all rooms shall be fitted with electric lighting and power points as instructed by the Engineer's Representative, and each door shall be fitted with a good quality mortise lock and provide with two keys.

Soaking tanks for Concrete Cubes specimens shall be provided at floor level in the laboratory. Concrete cube curing tanks of adequate size shall also be provided. The concrete cube curing shall have drainage pipes built in.

The following rooms and facilities shall be provided in the Laboratory;

(i) Office

This room shall have a total floor area of not less than 14 square metres and a total window area of not less than 2 square meters. The door and windows shall be fitted with fly screens covered with mosquito gauze. The floor shall be of concrete with a float finish. The walls shall be lined and ceiling provided.

A display board of soft-board or similar approved material shall be provided and fixed

securely to the wall at a location to be indicated by the Engineer.

(ii) Main laboratory room

This room shall have a total floor area of not less than 55 m² and a total window area of not less than 7 m². The external entrance shall be a double door and single doors shall be provided for access to adjacent offices.

The permanent fixtures in the Laboratory shall include three double draining board stainless steel sinks, piped potable water supply to each and waste water outlets. The room shall be fitted with three rigidly constructed work benches 0.9 m high by 1 m wide and with a top comprised of either metal lined hardwood or steel float finished concrete (at least 75 mm thick and suitably reinforced). A total length of workbenches approximately of 15 m shall be provided. Wall shelves 450 mm wide and having a surface area of at least 6 m² shall be provided and securely fitted.

Concrete plinths suitable for mounting the cube crusher and CBR load frame shall also be provided.

Two display boards made of soft-board or other approved material, each with a minimum area of 3 m², shall be securely fixed to the walls as directed by the Engineer.

(iii) Small laboratory room

A small laboratory room shall be provided. This room shall have a total floor area of not less than 20 m² and a total window area of not less than 2 m². A door shall provide access to the main laboratory room. The floor shall be fitted out as indicated by the Engineer's Representative with two rigidly constructed workbenches constructed to the same standard of construction as the main laboratory room. The workbenches shall be at least 6 m long. A sink with waste pipe shall be connected to the water supply of the main laboratory room in addition an approved air extractor shall be fitted through an outside wall.

(iv) Store room

A separate sample store, of at least 20 m² floor area and with shelves along one wall, shall be provided in a position to be indicated by the Engineer.

(v) Concrete slab

A concrete slab, 150 mm thick with a total area of not less than 20 m² shall be provided adjacent to the main laboratory building in a position to be indicated by the Engineer's Representative. The slab shall have a smooth finish, all to the satisfaction of the Engineer. The laboratory shall revert to the Contractor at the end of the contract.

1.24.22. Engineer's housing, office and laboratory furniture

Furniture and equipment for the Engineer's Laboratory shall be as listed appendix of this specification. It shall be the Contractor's responsibility to replenish consumables, when instructed by the Engineer.

The Engineer's Housing, office and laboratory furniture will revert to the Contractor on completion of the contract.

1.24.23. Engineer's laboratory and survey equipment

The Contractor shall provide, install and maintain in a good state of repair for the duration of the Contract, such laboratory, survey and other equipment as listed in the appendix of this specification. Such equipment shall be of approved manufacture, and shall be made available to the Engineer within the following time periods:

- Survey equipment - not more than 30 days after Engineer's order to supply
- Laboratory equipment - not more than 60 days after Engineer's order to supply

Any delays to the Contractor or the Contractor's activities caused by the Engineer being unable to perform survey work, field or laboratory tests due to the Contractor's failure to supply and/or maintain the said equipment shall be deemed to have been caused by the Contractor's own actions, and any consequences of such delays shall be interpreted as such.

The laboratory and survey equipment shall revert to the Employer on completion of the contract.

1.24.24. Maintenance of the Engineer's Staff Houses, Offices, Laboratories, Furniture and Equipment

The Contractor shall keep all buildings, accesses, services and facilities provided by him, for the use of the Engineer and his staff, in a well maintained, clean and fully habitable

condition, 24 hours per day until the issue of the Taking Over Certificate for the whole of the Works, and if required for a period thereafter until the Contractor has completed any outstanding work.

The Contractor shall also provide constant electricity, water and an adequate refuse collection service for all houses, offices and laboratories.

The Contractor shall also maintain all furniture and equipment provided by him and/or the Employer in a reasonable state of repair and useable condition and shall replace promptly any item which becomes unserviceable or is lost.

1.25. Provision of Maintenance and Security

The contractor shall provide cleaners, groundsmen, and day and night watchmen for housing camp and offices as directed or instructed by the Engineer on site, the cost of which shall be included in the rates for providing houses, offices and laboratory.

1.26. Insurance and ownership of the Engineer's Staff Houses, Offices, Laboratories, Furniture and Equipment

All buildings, furniture and equipment provided by the Contractor for the Engineer's staff shall be insured by the Contractor against loss or damage by accident, fire, theft and other risks ordinarily insured against for the duration of the Contract.

On completion of the contract the ownership of the office, laboratory and survey equipment shall revert to the employer. Unless otherwise stated ownership of all houses and laboratories shall revert to the contractor.

1.27. Provision of Vehicles

All vehicles to be supplied will be brand-new, right-hand drive, diesel powered and fitted with air-conditioner and power steering as described below.

Type 1. - new Turbo diesel propelled 4WD, 5 door 7-seater station wagon vehicle of minimum engine capacity 3000cc, 410Nm @ 1600rpm, 125kW/3400rpm power, 90trs fuel tank capacity fitted with all the necessities mentioned in paragraph one of this clause for the exclusive use of the Engineer.

Type 2. - new Turbo diesel propelled 4WD, 4 door 5-seater Double Cabin pick up vehicle of minimum engine capacity 4164cc, 285Nm/2200rpm torque, 96kW/3800rpm power, 130ltrs fuel tank capacity fitted with all the necessities mentioned in paragraph one of this clause for the exclusive use of the Engineer.

1.28. Contractor's Vehicles for the Engineer's use

The Contractor shall supply new vehicles and maintain them for the exclusive use of the Engineer and his staff, for any purpose whatsoever authorised by the Engineer.

A description of the Number and the types of vehicle to be provided is given in the bill of quantities.

The vehicles supplied for use by the Engineer's staff on site shall be owned by the Contractor and be licenced (inspection sticker) and comprehensively insured by the Contractor for use within Kenya by licenced driver authorised by the Engineer together with authorised passenger and the carriage of goods and samples. The contractor shall pay all tolls, provide fuel, oil, maintenance including replacing defective parts, tyres and the like whenever required, in conformity with the vehicles manufacturer's recommendations or as may be necessary. The vehicles shall be fuelled, oiled and maintained as aforementioned until released by the Engineer.

The vehicles on being released shall revert back to the Contractor. Each vehicle shall be fitted with fire extinguisher, first aid kit, tow hook and rope, tool kit, spare wheel, wheel wrench, jack and handle and seat belts all of which shall be maintained in working order or replaced by the contractor as necessary.

1.29. Employer's Vehicles

The Contractor shall supply new vehicles and maintain them for the exclusive use of the Employer's staff. A description of the Number and the types of vehicle to be provided is given in the bill of quantities.

The vehicles supplied for use by the Employer shall be exclusively owned by the Employer and be licenced (inspection sticker) and comprehensively insured by the Contractor for use within Kenya. The contractor shall pay all tolls, provide maintenance that includes replacing defective parts, tyres and periodic general servicing of the vehicle whenever required, in conformity with the vehicles manufacturer's recommendations or as may be necessary. The vehicles shall be maintained as aforementioned until the end of the contract. Each vehicle shall be fitted with car track as approved by the Engineer, fire extinguisher,

first aid kit, tow hook and rope, tool kit, spare wheel, wheel wrench, jack and handle and seat belts all of which shall be maintained in working order or replaced by the contractor as necessary till the end of the Contract. The Contractor shall provide a similar replacement for any vehicle out of service for more than 24 hours.

1.30. Removal of Camps

On the completion of the Contract, the Contractor shall if so requested take down and remove all structures connected with his camp, and shall take up all pipes, drains and culverts, backfill trenches, fill up all latrine pits, soak ways and other sewage disposal excavations, and shall restore the site as far as practicable to its origin condition and leave it neat and tidy to the satisfaction of the Engineer.

1.31. Site Meetings

Site meetings will be held monthly, but will be called for whenever the progress of the works so require or when demanded by the Engineer.

The Contractor shall at all meetings be represented by a responsible representative other than the Site Agent, who has the powers to commit the Contractor in all matters concerning the contract.

In the event no responsible representative of the Contractor is present at the meetings, any decision taken by the Engineer at the meeting will be binding upon the Contractor.

1.32. Miscellaneous Accounts

The Contractor may be instructed by the Engineer to make payments of general receipted accounts for such items as stationery, stores, furniture and equipment, claims and allowances for supervision personnel and any miscellaneous claims or the Engineer may direct the Contractor to purchase or pay for the above. The Contractor will, on provision of receipts, be paid under appropriate items in the Bill of Quantities

1.33. Payment of Overtime for Engineer's Junior Staff

The Contractor may be instructed by the Engineer to make payments for overtime worked by the Engineer's junior staff. The Contractor shall be reimbursed for such payments in accordance with the relevant items of the clause 1.51 of this specification except when any overtime worked by the engineer's junior staff is incurred by the need for the engineer to inspect work which, owing to earlier default by the contractor, has resulted in such work being performed outside the normal working hours as defined in clause 1.37 of this specification then the full cost of such overtime including the specified percentage for administrative overheads shall be paid by the Contractor to the Engineer.

(i) If the Contractor wishes to execute permanent work outside the Engineer's normal working hours, as stated in Clause 1.37 of this Specification, then the payment for the overtime for Engineer's support staff shall be reimbursed in full by the Contractor to the Engineer. For purposes of this clause, in addition to the support staff provided by the contractor, the following shall also constitute part of the Engineer's junior staff

Designation	Number
Survey assistants/leveller	4
Senior lab Technologist	1
Lab Technologist	4
Inspectors	6
Draftsman	1
Secretary/Typist	1
Clerk	1

(ii) If the Contractor wishes to execute permanent works on a regular basis outside the Engineer's normal working hour, (Clause 1.37 of this Specifications) over a prolonged period, the Engineer may, if he deems it necessary, employ additional supervisory staff for which the required salaries, plus twenty (20) percent additional amount to cover for the Engineer's overheads shall be reimbursed in full by the Contractor to the Engineer and the Contractor shall provide the required accommodation facilities for such staff at his own cost.

(iii) Payment of Allowance on Duty Trips. The Contractor is required to pay for hotel accommodation and allowances for his staff seconded to the Engineer on official duty trips outside the base camp. The Contractor shall not be reimbursed any of these costs (i.e.

i,ii,iii)

1.34. Water proofing

The Consultant shall work carefully with waterproofing manufacturers and obtain constructability input from the contractor prior to giving any instructions on the type of waterproofing system and components to be used. It is recommended that the Product Performance, Application Techniques and General Condition factors listed in here below be carefully considered in reviewing and selecting the appropriate waterproofing system.

The following shall be important Waterproofing Specifications factors to be considered

- i. Qualifications of the Applicator,
- ii. Submittals - Evidence of Applicator Qualifications,
- iii. Manufacturer's Certificate of Conformance, Catalog,
- iv. Application Data, and Samples,
- v. Delivery and Storage of Materials,
- vi. Environmental Conditions,
- vii. Carefully review the Physical Performance, Application,

Ensure that product materials comply with these requirements, the structural design and other design criteria;

- Membrane should be impermeable to water but allow water vapor to pass,
- Membrane should provide a continuous film without areas of weakness and lend itself to the design details of the structure,
- Materials selected must be compatible
- Ensure that surface to be treated has been prepared to provide a positive bond to minimize the lateral migration of water,
- Application of the waterproofing products must be specified in accordance with the manufacturer's requirements,
- The membrane selected should maintain its physical properties such as elasticity and durability, over wide range of environmental conditions,
- Quality control specifications should be reviewed to ensure that each phase is properly inspected and tested prior to proceeding with the next phase. Testing of the installed waterproofing system prior to and after backfilling, by the continuous application of water over extended periods of time, is essential and should be specified,
- The waterproofing system should be guaranteed for both material and performance by the installing contractor. Manufacturers' representatives should also be required by specification to be on site during the installation of their product.

1.35. Measurement and payment

No separate measurement and payments shall be made for the cost of complying with the requirements of clauses 1.1 to Clause 1.10, Clause 1.12, Clause 1.14 to Clause 1.33, Clause 1.35 to Clause 1.40, Clause 1.43, Clause 1.44, Clause 1.46, Clause 1.47 and Clause 1.50 of this specification and the Contractor shall be deemed to have allowed elsewhere in his rates and price for all such costs.

- a. No preliminary item has been included in this Contract. All Contractor's mobilisation and general costs shall therefore be included in relevant rates in the Bill of Quantities.
- b. Clause 1.11: Relocation of Existing Services Unit: Prime Cost Plus % for Contractors overheads and profits

Reimbursement for the removal of or alteration to existing services which are affected by the works shall be paid under the contingency as a prime cost basis plus a % for overheads and profits. This percentage shall be deemed to include for all costs incurred in liaising with the appropriate bodies and for programming and coordinating work to enable any removal or alteration to the service to be carried out and complying with the requirements of clauses 1.11 and clause 1.20 of this specification.

- c. Clause 1.14: Use of Public Roads Unit: Provisional Sum

Reimbursement for use and maintenance of public roads, and other works required for construction of permanent works shall be on a provisional cost basis and payments shall be on daywork basis. This costs incurred shall include for liaising with the appropriate bodies and for programming and coordinating work and complying with the requirements of Clause 1.14, Clause 1.15, and Clause 1.20 of this specification.

d. Clause 1.25: Signboards Unit: No. of each type

The rate shall include the cost of complying with clause 1.25 and costs incurred in liaising with the appropriate bodies and levies as may be applicable under relevant local and national laws.

e. Clause 1.34: Sampling and analysis of clean water in the system. Unit: Prime Cost Plus % for Contractors overheads and profits

Reimbursement for the costs of the initial sampling, analyses and preparing reports on the quality of the water shall be on a prime cost basis plus a % for overheads and profits. This percentage shall be deemed to include complying with the requirements of Clause 1.33 and Clause 1.34 of this specification.

f. Clause 1.41: Engineer's Communication. Unit: Prime Cost Plus % for Contractors overheads and profits

Reimbursement for the costs of providing and maintaining mobiles telephones, VSAT internet connection, post office, courier, radio communication shall be on a prime cost basis plus a % for overheads and profits. This percentage shall be deemed to include for all costs incurred in liaising with the appropriate bodies for licensing, registering, erecting and maintenance of the communication services and the cost of complying with the requirements of Clause 1.42 of this specification.

g. Clause 1.42.1 Housing Accommodation for Engineer's Senior Staff: Unit: No. of each type

Engineer's Senior Staff houses shall be measured by the number instructed to be built. The rate of the Engineer's Senior Staff houses shall include for the cost of providing the accommodation, electricity, water, telephone charges and heating in accordance with instructions issued by the Engineer and shall comply with the requirements of Clause 1.42 and Clause 1.43 of this specification.

Payment for the engineer's staff houses shall be made in instalments in accordance with the following conditions: -

- (i) 50% (fifty percent) of the sum when the housing, office and laboratory, as appropriate, have been erected, furnished, equipped, accepted and handed over to the Engineer.
- (ii) 50% (fifty percent) of the sum in equal monthly instalments spread -over the period from the date when the houses, offices, or the laboratory as appropriate is taken over by the Engineer until the end of the Contract excluding the Maintenance Period.

This payment shall be deemed to cover servicing and maintenance of buildings, furniture, equipment and services and the Engineer may withhold or reduce any instalments if the Contractor fails in his maintenance obligations. In the event of the Interim Certificate not being issued in any month, then the instalment shall be added to the subsequent certificate.

h. Clause 1.42.2 Housing Accommodation for Engineer's Junior Staff: Unit: No. of each type

Engineer's junior staff houses shall be measured by the number instructed to be built. The rate of the Engineer's junior staff houses shall include for the cost of providing the office, electricity, water, telephone charges and heating in accordance with instructions issued by the engineer and shall comply with the requirements of Clause 1.42 and clause 1.43 of this specification.

Payment for the engineer's junior staff houses shall be made in instalments in accordance with clause 1.50 (g) of this Specification.

i. Clause 1.42.3 Engineer's Office: Unit: No.

Engineer's office shall be measured by the number instructed to be built. The rate of the Engineer's office shall include for the cost of providing the office, electricity, water, telephone charges and heating in accordance with instructions issued by the engineer and shall comply with the requirements of Clause 1.42 and clause 1.43 of this specification.

Payment for the engineer's office shall be made in instalments in accordance with clause 1.50 (g) of this Specification.

j. Clause 1.42.4 Laboratory: Unit: No.

Laboratory shall be measured by the number instructed to be built. The rate of the Laboratory shall include for the cost of providing the office, electricity, water, telephone charges and heating in accordance with instructions issued by the engineer and shall comply with the requirements of Clause

1.42 and Clause 1.43 of this specification. Payment for the Laboratory shall be made in instalments in accordance with clause 1.50 (g) of this Specification.

k. Clause 1.45.1 Contractor's Vehicles for the Engineer use

i) Unit: V. month for each type of vehicle

Provision of vehicles for the engineer shall be measured by the vehicle month (V. month) for each month, or part thereof, that the vehicle is provided for the engineer.

Payment for the vehicles (up to 4,000km per Veh.month) shall be by vehicle months.

ii) Units: Kilometers

Payment for mileage above 4,000km per vehicle month shall be at a rate per kilometer. The rate shall include for all fuels, lubricants, servicing insurance, maintenance, driver and repairs. The km rate shall include any overtime the driver might be due or any other allowances in addition to the normal working hours. Payment shall be under appropriate items in the Bill of Quantities.

In addition, the rate for running costs of vehicles shall also include:

(i) Cost of any repairs necessary as shall be required to meet roadworthiness and compliance with registration requirements

(ii) Any other repairs as shall be instructed by the Engineer

The rate shall include for the cost of complying with the requirements of clause 1.45 of this specification.

1. Clause 1.45.2 Employer's Vehicles

i) Unit: No. of each type

Provision of vehicles for the employer's exclusive use shall be measured by the number of each type of vehicle provided.

ii) Units: Kilometers

Payment for each kilometre travelled by the vehicle per month shall be at a rate per kilometer. The rate shall include for all fuels, lubricants, servicing insurance, maintenance and repairs. The rate shall include for the cost of complying with the requirements of clause 1.45 of this specification.

m. Clause 1.48 Miscellaneous account Unit: Prime Cost Sum: Plus % for Contractor's overheads and profits

The Contractor, on provision of receipts, will be reimbursed on a prime cost basis for miscellaneous accounts plus a percentage for overhead and profits. This percentage shall be deemed to include for all costs in providing the items in the miscellaneous account including purchase, transport to site and complying with the requirements of clause 1.48 of this specification.

n. Payment of overtime for the Engineer's junior staff Unit: Prime Cost Sum: Plus % for Contractor's overheads and profits

Reimbursement for the payments of the Engineer's junior staff overtime shall be on a prime cost basis plus a percentage for overheads and profits. This percentage shall be deemed to include for all costs of complying with clause 1.49 of this specifications

2. MATERIALS AND TESTING OF MATERIAL

2.1 Information from Exploratory Borings and Test Pits

Factual Materials Report

The Factual Materials Report for this Contract does not form part of the Contract Documents.

However, the Report will be made available for the Contractor's information only, and any conclusions on issues such as suitability of materials, location of borrow pits, material quantities etc., made by the Contractor on basis of the Factual Materials Report, will be at his own risk and at no extra cost to employer.

Trial Sections

The Contractor shall allow in his programme for constructing trial sections and carrying out tests upon them as directed by the Engineer. Trials would normally be required at the start of each structure and if changes of materials, method or equipment deem it necessary as directed by the Engineer. The time for completion of the Contract shall not be extended because of the time needed to construct trial sections and evaluate the tests on them.

No variation in the construction procedure, mix proportions, size, grading or source of any of the constituents shall be made without the agreement of the Engineer.

Trial sections, if found satisfactory, will be paid for under the rates in the Bill of Quantities for the appropriate items, as if the trial sections were part of the normal work. No separate payment will be made for trial sections and testing.

The Contractor shall make good, at his own expense; any trial sections that fail to meet the specified standards. The standards shall include, but not be limited to, material quality, layer thickness, levels and compaction.

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 reading of these Specifications, 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.

All works or parts thereof shall be in accordance with the latest edition of either Kenya Bureau of Standards (K.E.B.S.) Specifications, or International Standards Organization (I.S.O.) Specification or British Standard (B.S.) Specifications and British Codes of Practice (CP.) as published by British Standards Institution.

All materials shall be of approved manufacturer and origin and the best quality of their respective kind, equal to sample and delivered on to the Site a sufficient period before they are required to be used in the Works to enable the Engineer to take such samples as he may require for testing or approval, and the Contractor shall furnish any information required by the Engineer as to the quality, weight, strength, description, etc. of the materials. No materials of any description shall be used without prior approval by the Engineer and any condemned as unfit for use in the Works shall be removed immediately from the Site by, and without recompense to, the Contractor.

2.2. Trade Names

Trade Names and Catalogue References are given solely as the guide to the quality and alternative manufacturers of the materials or goods of equivalent quality will be accepted at the discretion of the Engineer.

2.3. Samples

Samples of all materials shall be deposited with the Engineer and approved prior to ordering or delivery to site. The Engineer reserves his right to test any sample to destruction and retain samples until the end of the maintenance period. No payment will be made for samples and the Contractor must in the rates of prices allow for costs of samples. All materials delivered to site shall be equal or better in all respects than the samples delivered to the Engineer.

All sampling of materials on the site must be done by or in the presence of the Engineer. All other samples will be deemed not to be valid under the Contract.

Any material delivered to the site or intended for the works not equal or better than the samples approved by the Engineer shall be removed and replaced at the Contractor's expense.

2.4. Testing

As provided in Clause 7 of the Conditions of Contract and in accordance with the Specification quoted for any material used on works of this Contract, tests may be called upon by the Engineer to be carried out at the place of manufacture or on the site. The Contractor may assume that the tests will be required on soils, workmanship, and materials whether natural or manufactured to verify their compliance with the specifications. Samples of all such materials and manufactured articles together with all necessary labour, materials, plant and apparatus for sampling and for carrying out of the tests shall be supplied by the Contractor at his own expense.

2.5. Testing at an independent laboratory

A prime cost item has been included in Bills of Quantities for testing of materials and workmanship as directed by the Engineer at an Independent Laboratory. The Contractor will be reimbursed receipted cost of testing carried out by the laboratory if the workmanship or materials pass the tests. However, if the result of tests shows that material is defective then the Contractor will bear the cost of testing.

2.6. Standards

Summary of British Standards Applied in the Final Design and Specifications are as follows. It should be noted that the latest version of each of the following standards are the applicable version under this contract.

	Reference	Description	Remarks
1	BS 4: Part 1: 1972	Hot rolled Sections	
2	Part 2: 1969	Hot rolled hollow sections	
3	BS4: Part 1: 1958 Part 2: 1971	Portland cement (Imperial units)Portland cement (Metric Units)	
4	BS21: 1973	Pipe threads for tubes and fittingswhere pressure-tight joints are made on the threads.	
5	BS 143: 1968	Malleable cast iron and cast alloyscrewed pipe fittings for Steam, air, water, gas and oil	
6	BS 416: 1973	Cast iron spigot and soil, waste and ventilating pipes (sand castand spun) and fittings	
7	BS 437:	Cast iron spigot and socket drainpipes and fittings	
8	BS 437: Part 1 1970	Pipes, bends, branches andfittings.	
	BS 449:	The use of structural steel inbuilding.	
9	BS 449: Part 1: BS 449: Part 2:	Imperial Units Metric units	
10	BS 449: Supplement No. 1 (P.D. 4064) to 449:	The use of cold formed steel sections	
11	Part 1: 1970 Addendum No. 1 (1975)to	In building	
12	BS 449: Part 2: 1969	The use of cold formed steel sections in building	
13	BS 459:	Doors	
14	BS 459: Part 2: 1962	Flush doors	
15	BS 459: Part 4 1965	Match boarded doors	
16	BS 534: 1966	Steel pipes, fitting and specials for Water, gas and sewage	
17	BS 556:	Concrete cylindrical pipes and fittings including manholes, inspection chambers and street gullies	
18	BS 556: Part 2: 1972	Metric units.	
19	BS 639: 1976	Covered electrodes for the manual metal-arc welding of carbon and carbon manganese steels	
20	BS 743: 1970 1970	Material for damp proof courses.Metric units	

21	BS 747: Part 2: 1970	Roofing felts. Metric units.	
22	BS 864: Part 2: 1971	Capillary and compression tubefittings of copper and copper alloy. Metric units.	
23	BS 882:	Aggregates from natural sources for concrete (includinggranolithic)	
24	BS 882: Part 1: 1965 BS 882: Part 2 1973	Imperial units Metric units	
25	BS 890: 1972	Building lines	
26	BS 952: 1964	Classification of glass for glazing and terminology for work on glass.	
27	BS 1010:	Draw-off tops and stop valves for water services (screw down pattern)	
28	BS 1010: Part 1: 1959	Imperial units	
29	BS 1010: Part 2: 1973	Draw-off taps and above-groundstop valves M.	
30	BS 1030: 1943	Schedule of cast iron drain fittings, spigot and socket type, for use with drain pipes to BS 437.	
31	BS 1142:	Fibre building boards	
32	BS 1142: Part 3: 1972	Insulating boards (soft boards)	
33	BS 1184: 1976	Copper and copper alloy traps.	
34	BS 1186:	Quality of timber and workmanship in joinery	
35	BS 1186: Part 1: 1971 BS 1186: Part 2: 1971	Quality of timber Quality of workmanship	
36	BS 1212:	Ball valves (excluding floats)	
37	BS 1212: Part 1: 1953 BS 1212: Part 2: 1970	Piston type Diaphragm type (brass body)	
38	BS 1256: See BS 143		
39	BS 1377: 1975	Methods of test for soil for civil engineering purposes	
40	BS 1387: 1967	Steel tubes and tubulars suitablefor screwing to BS 21 pipe threads	
41	BS 1722: BS 1722: Part 1 1972	Fences Chain link fences	
42	Supplement No. 1 (1974) to BS 1772: Part 1:	Gate and gate posts used in conjunction with chain linkfences.	
43	BS 1881:	Methods of testing concrete	

44	BS 1881: Part 1: 1970 BS 1881: Part 2: 1970 BS 1881: Part 3: 1970 BS 1881: Part 4: 1970 BS 1881: Part 5: 1970 BS 1881: Part 6: 1971	Methods of sampling fresh concrete Methods of testing fresh concrete Methods of making and curing test specimen. Methods of testing concrete for strength. Methods of testing hardened concrete for other than strength Analysis of hardened concrete	
45	BS 2028: 1968	Precast concrete blocks	
46	BS 2494: 1976	Materials for elastomeric joint rings for pipeworks and pipelines	
47	BS 2871:	Copper and copper alloys, Tubes.	
48	BS 2871: Part 1: 1971 BS 2871: Part 1: 1972 BS 2871: Part 3: 1972	Copper tubes for water, gas and Sanitation Tubes for general purposes Tubes for heat exchangers.	
49	BS 3148: 1959	Test for water for making concrete	
50	BS 3248: 1967	Polythene pipe (Type 50) for cold water services	
51	BS 3416: 1975	Black bitumen coating solution for cold application	
52	BS 3505: 1968	Unplasticised PVC pipe for cold water services	
53	BS 3601: 1974	Steel pipes and tubes for pressure purposes: carbon steel with specified room temperature properties.	
54	BS 4133: 1967	Flanged steel parallel slide valves for general purposes	
55	BS 4164: 1967	Coal tar-based hot applied coating materials for protecting iron and steel, including suitable primers where required	
56	BS 4164: 1967	Isometric black hexagon bolts, screws and nuts.	
57	BS 4254: 1967	Two-part polysulphide-based sealants for the building industry	
58	BS 4320: 1968	Metal washers for general engineering purposes	
59	BS 4360: 1972	Weldable structural steels.	
60	BS 4449: 1969	Hot rolled steel bars for the reinforcement of concrete.	
61	BS 4461: 1969	Cold worked steel bars for the Reinforcement of concrete.	
62	BS 4466: 1969	Bending dimensions and scheduling of bars for the reinforcement of concrete	
63	BS 4483: 1969	Steel fabric for the reinforcement of Concrete.	
64	BS 4505:	Flanges and bolting for pipes, valves and fittings. Metric	

		series	
65	BS 4505:Part 1: 1969	Ferrous.	
66	BS 4772: 1971	Ductile iron pipes and fittings.	
67	BS 4848:	Hot-rolled structural steel sections.	
68	BS 4848:Part 2: 1975 BS 4848:Part 4: 1972	Hollow sections Equal and unequal angles	
69	BS 5135: 1974	Metal-arc welding of carbon and carbon manganese steels	
70	BS 5151:	Cast iron gate valves for general purposes	
71	BS 5153: 1974	Cast iron check valves for general purposes	
72	BS 5155:	Cast iron and carbon steel butterfly valves for general purposes	
73	BS 5163: 1974	Double flanged cast iron wedge gate valves for waterworks purposes	
74	BS 8007: 1987	Code of practice for the structural use of concrete for retaining aqueous liquids (formerly BS 5337)	
75	BS 8110: 1985	The structural use of concrete.	
76	BS 5328: 1985	Method of specifying concrete including ready mix concrete	
77	12201-2002 Part 1	Plastics piping systems for sewerage under pressure - water supply, and for drainage and Polyethylene (PE) - Part 1: General	
78	12201- 2011 Part 2	Plastics piping systems for water supply, and for drainage and sewerage under pressure - Polyethylene (PE) - Part 2: Pipes	
79	12201-2011 Part 3	Plastics piping systems for water supply, and for drainage and sewerage under pressure - Polyethylene (PE) - Part 3: Fittings	
80	12201-2011 5	Plastics piping systems for water supply, and for drainage and sewerage under pressure polyethylene (PE)	
81	CP 112:: Part 2: 1971	The structural use of timber	
82	CP 112:: Part 3: 1973	Trussed rafters for roofs of dwellings	
83	CP 231:: 1966	Painting of buildings	
84	CP 301: 1971	Building drainage	
85	CP 308: 1974	Drainage of roofs and paved areas	
86	CP 310: 1965	Water supply	
87	CP 2010	Pipelines	
88	CP 2010:Part 1: 1971	Installation of pipelines in land	
89	CP 2010:Part 2: 1970	Design and construction of steel pipelines in land	
90	CP 2010:Part 3: 1972	Design and construction of iron pipelines in land	

2.7. Measurement and payment

Except where payment items are provided for certain materials and required tests, no separate measurement and payment shall be made for materials and tests and the cost thereof shall be included in the appropriate tendered rates.

3. SITE CLEARANCE AND TOP SOIL STRIPPING

3.1. Site Clearance and Grubbing

Site clearance shall generally be restricted to the areas under permanent works without any provision for working allowance and/or as instructed by the Engineer. No separate measurement and payment will be made for site clearance of areas cleared by the Contractor for the Storage of Construction materials, camps, housing, workshops, stores, quarries, temporary works, and working space. The contractor's rates and prices are deemed to include for this work.

Clearing shall involve the following:

- The removal of all trees and bushes (complete with roots), other vegetation, rubbish and all other material that may interfere with the construction of the Works.
- The removal of all rocks and boulders of up to 0.15 m in size, which are lying on the surface to be cleared or which are exposed during the clearing operations.
- The disposal of all material produced by the clearing.
- The removal and disposal of structures which encroach upon or may otherwise obstruct other work on the Site and which can be cleared by means of a bulldozer with a mass of approximately 20 t and a flywheel power of approximately 130 kW. (Structures that cannot be so cleared shall be dealt with as directed by the Engineer.)

Unless instructed, the site clearing for trenches shall only be for the width allowed for trench excavation.

The moving of a certain amount of soil or gravel may be inherent in or unavoidable during the clearing process. No extra payment will be made for the removal of such soil or gravel.

Areas that are cleared in strips for the purpose of constructing fences shall be cleared over the full length of the fence to a width as specified in the drawing and as instructed by the Engineer. Surface irregularities shall, in the case of fencing, be so graded that the fence will follow the general ground contour.

All stumps and roots exceeding 75 mm in diameter shall be removed to a depth of at least 100mm below the original ground level. Where a construction bed or any other area has to be compacted, all stumps and roots including matted roots shall be removed to a depth of at least 200 mm below the cleared surface.

All material produced by the grubbing shall be disposed of.

Except in borrow areas, cavities caused by grubbing shall be backfilled with approved material and compacted to a density equal to at least that of the surrounding ground.

3.2. Cutting Trees

a. Protection of persons, animals and structures

The Contractor shall take the necessary precautions to prevent injury to persons and animals and damage to structures and other private and public property.

Where necessary, trees shall be cut in sections from the top downwards.

b. Branches overhanging boundaries

The branches of trees to be left standing shall be so trimmed as not to encroach upon the space (to a height of at least 7 m) vertically above any carriageway, railway formation, or other designated area.

c. Preservation of trees

No tree shall be cut down and no branches shall be trimmed off any of the trees to be preserved until the Engineer has given written authorization for such work to

commence. Individual trees indicated and marked by the Engineer as trees to be preserved shall be left standing and undamaged.

3.3. The Disposal of Material

Any material obtained from clearing and grubbing, the demolition of structures, the re-clearing of vegetation and the cutting of trees shall be disposed-off in borrow pits or other suitable places indicated by the Engineer. Where no such place for the disposal of material is indicated by the Engineer, the Contractor shall make his own arrangements to provide a suitable place which complies with the requirements laid down by the Engineer. The disposal or burning if specially permitted of combustible material on the Site may be done only with the prior written approval of the Engineer. Care shall be taken to observe the air pollution under EMCA 1999.

All tree trunks and major branches shall be sawn into transportable lengths before removal from the Site.

No haulage will be payable to the Contractor for the disposal of material obtained from clearing and grubbing, the demolition of structures, the re-clearing of vegetation, and from the cutting of trees.

Materials from stripping such as suitable topsoil shall, if instructed by the Engineer, be stacked in approved areas. All other non-combustible materials shall be buried in approved disposal area; covered with a minimum of 0.5m of excavation spoil. These disposal areas shall be left with neatly graded surfaces and stable slopes that assure drainage. Alternatively, the non-combustible material shall be removed from the area by the Contractor.

3.4. Removal of Topsoil

Topsoil shall be removed to spoil or stockpile where and as directed by the engineer. Spoil material shall be deposited in compliance with the relevant national and local laws and regulations. Measurement shall be the net area in square metres removed as directed and shall allow for stripping topsoil to a depth of 200mm. Should the Engineer instruct that a greater depth than 200mm be removed, payment for the additional material shall be made under the item for excavation in the Bills of Quantities.

The topsoil shall be removed from over the full width of the trench to a depth of 200 mm or if rock occurs closer than 200 mm to the existing natural surface. On completion of backfilling, the topsoil shall be replaced in its original position.

Should the Contractor strip to depths greater than those instructed by the Engineer, then the Contractor shall replace the material with suitable fill material at his own expense.

3.5. Measurement and payments

- a. Clause 3.1. Site Clearing and grubbing Unit: Areas square metre (m)

The unit of measurement for clearing and grubbing is the square metre or metre.

Only those areas or strips designated by the Engineer under clause 3.1 of this specification shall be cleared and grubbed in accordance with the requirements of Clause 3.1 and Clause 3.3 of this specification shall be measured for payments.

The tendered rates shall include full compensation for clearing the surface, removing boulders with a size of up to 0.15 m³, cutting trees with single or multiple trunks each with a girth of

0.5 m or less, grubbing the stumps and roots of such trees, cutting trunks and branches into transportable lengths, backfilling cavities, demolishing structures, and removing, transporting and disposing of material thus cleared, grubbed, cut and demolished. Boulders exceeding 0.15m in size shall be dealt with as set out in Earthworks Section of this Specification.

- b. Clause 3.2 Cutting and removing large trees with a girths exceeding 0.5m

Unit: Exceeding 0.5m and up to and including 2m

number (No) Exceeding 2m and up to and including

3m number (No)

The unit of measurement shall be the number of tree trunks cut and removed in each size group. The girth of a tree trunk will be measured at the narrowest point of the

trunk in the first metre of its height above ground level.

The tendered rates shall include full compensation for cutting the trees and grubbing the stumps, for cutting the trunks and branches into transportable lengths, and for removing, transporting and disposing of all such trees, stumps, trunks, branches and associated material.

- c. Grubbing and the removal of the stumps and roots of large trees with a girth exceeding 0.5m

Unit: Exceeding 0.5m and up to and including 2m

number (No) Exceeding 2m and up to and including

3m number (No)

The unit of measurement shall be the number of tree stumps and associated roots of which were grubbed and removed in each size group.

The tendered rates shall include full compensation for grubbing the stumps and roots, backfilling holes, cutting the stumps and roots into transportable pieces, and removing, transporting and disposing of all such stumps and roots and associated material.

The girth of a tree trunk will be measured at the narrowest point of the trunk in the first metre of its height above ground level.

- d. Clause 3.4 Removal

of top soil Unit: m²

Removal of topsoil shall be measured by the square meters calculated as the plan area measured from cross-section taken in accordance with clause 1.26 of this specification.

The rate for removal of top soil shall include for the cost of all hauls as necessary and compliance with the requirements of clause 3.3 and clause 3.4 of this specification

4. EARTHWORKS

4.1. General

Excavation shall be made to such lengths, depths and inclinations as may be necessary for the construction of the works or as shown on the drawings or as the Engineer may direct.

4.2. Definitions of Materials

For the purpose of these Specifications materials of earthworks are classified as follows:

- (a) Hard material: Material which can be excavated only after blasting with explosives, or barring and wedging or boulders of more than 0.5m occurring in soft material shall be classified as hard material.

or

Rock is defined as solid masses, layers, or ledges of such hardness that it cannot be effectively loosened or broken by ripping with a track type tractor minimum flywheel power 250KW (335 HP) equipped with a single shank ripper and operating in low gear.

- (b) Soft Material: All earth materials, which do not meet the requirements of hard material as defined in above.

- (c) Overburden means soil as defined here above

Where it is impractical to prove hard material by the above method, then the quantity of hard material, if any, shall be determined by the engineer.

4.3. Scope

All the excavations covered in this section are open cut excavation also termed surface excavation in this contract:

- Excavation for cuttings (soil and rock)

This covers mainly excavations under the embankment dam (not including the core trench excavation itself), excavation for cofferdam, and excavation for the spillway.

- Core trench excavation (soil and rock)

This covers the excavation of the trench for the embankment dam core with its adjacent filter and transition,

- Excavation for culvert (soil and rock)

This covers the excavation of the trench for the culvert, the intake tower and the downstream valve chamber.

- Small size excavation (soil and rock).

- Excavation of earth fill material in borrow area

- Excavation of overburden in rock quarry. This covers the excavation of the soil cover in the quarry

- Excavation of rock fills R1, R2 (and R5 in the alternative)

4.4. Excavation

4.4.1 General

The excavations (except in the quarry and borrow area) shall be made to the lines, grades and dimensions shown on the drawings.

The Contractor shall take all necessary measures to ensure the stability and safety of excavations,

Excavations needed by the Contractor installations shall be submitted to the approval of the Engineer,

The determination of acceptable foundation levels for the detail design of the dam were based on the geological information obtained to date, notably the borehole logs and seismic refraction survey. The borehole logs were used to provide “fixed” excavation depths with the remainder of the information interpolated from this, using the seismic refraction survey as a guide. The final assumed excavation line as shown on the drawings is where it is expected that suitable material will be located to found the dam or where extended excavation is required to accommodate the core trench. In general, suitable material has been deemed to be the interface of moderately-weathered material and fresh rock except in cases where relatively large depths of intermittent fresh and slightly-weathered rock exist, in which cases this material has been deemed to be required to be removed.

The river bed on the axis of the proposed dam site is at el 2444 masl. The dam foundation is divided into the following three principal areas:

(i) The upstream area adjacent to the core and extending over a distance of almost 2 km upstream of the core reference line. This area covers the section beneath filter zones and rockfill.

(ii) The central foundation area beneath clay core within which the core trench will be located. (iii) The downstream foundation area underneath filter zones and rock fill.

For the purpose of defining the foundation areas, the boundary line between filter and clay core represents the dividing line between the upstream and downstream parts of the foundation.

The foundation quality requirements are most generous in the core trench, and least stringent beneath rockfill. The dam foundation area will be cleared and stripped as a separate exercise ahead of excavation work. Site clearance will involve cutting trees, followed by clearing and grubbing to remove stumps, roots, foliage and undesirable materials. Sod, topsoil and peat will be stripped and stockpiled for re-use.

On average, it is expected that a suitable foundation for the embankment can be reached after removing a thickness of 2 to 6 m of residual soil and highly weathered rock. The average depth of excavation will decrease progressively towards downstream.

Besides weathering conditions of the foundation rock, the excavation depth is influenced by general excavation shape requirements; in that the finished surface should have an undulating profile that is free of abrupt irregularities that may

cause differential settlement. The valley flanks on both sides are irregular and even vertical at certain points. Substantial trimming will therefore be required in order to create a rock surface against which fill can be placed so that no differential settlement within the dam body can occur. Foundation shaping will be particularly onerous in the core trench and will also need to extend much further downstream, particularly at lower elevations along the old river channel. Trimmed profiles will not be steeper than 1V:0.5H. If it is not practicable to excavate local overhanging rock faces, the rockface will be solidly faced with backfill concrete to achieve the same design profile. Consideration will be given to leaving relatively small areas untreated; as long as the near- vertical faces are limited to 2 m in height and do not extend more than 7.5 m horizontally.

Blasting may be required to trim vertical or overhanging rock outcrops to acceptable profiles. Large boulders or core stones that obstruct the excavation or subsequent filling will also need to be blasted so that they can be removed or used as rock fill. Bulk excavation of soil, alluvium and highly weathered rocks will be possible by hydraulic excavators. The assistance of bulldozers fitted with rippers will be necessary to remove moderately weathered rocks. The final surface of the foundation can be prepared by trimming using an excavator fitted with a flat blade.

The upstream part of the embankment will be founded on moderately weathered rock or better, with some areas founded on relatively firm strata where depth of overburden is high. The upstream foundation will be heavily loaded and therefore needs to be on relatively firm strata so as to avoid excessive movement of the upstream face. The downstream part of the embankment will carry much less of the reservoir load and can be founded on a weaker foundation comprising predominantly moderately weathered rock or firm strata. Hard material remaining between areas of in-situ fresh rock will be left in place after shaping and trimming the overall area to an acceptable profile. Pockets of soft material, seams and other defects below the general level of the foundation will be excavated and filled with rock fill material.

Erodible foundation material left in place under the embankment especially beneath rock fill on the downstream side will have to be protected by filters in order to prevent the migration of foundation material into the rock fill, which could occur as piping due to seepage or from washing by rainwater that percolates through the rock fill. Erosion protection of the foundation will involve placing various layers of fill materials to form filter mattresses. In the core trench, it may be necessary to cap erodible material with shotcrete before placing the filter mattress.

The Contractor shall carefully set aside the various suitable materials encountered so that they may be reused for backfilling. If the excavated materials are unsuitable the Contractor may spoil the material only after approval by the Engineer. No extra claim will be allowed for setting aside surface material or topsoil for reuse or spoil.

4.5. Ground Levels and Reconstruction Cross Sections

Before the commencement of any earthworks the sites shall be surveyed in conjunction with the Engineers Representative to establish existing ground levels and these agreed ground levels shall form the basis for the calculation of quantities of any subsequent excavation and filling.

4.6. Topographical and Geological Survey after Excavation

A topographical survey of the excavated areas (except earthfill borrow area) shall be carried out by the Contractor at his own expense under the control of the Engineer. On the topographical map obtained the Contractor shall draw any geological accident, fault, and seams with all their details.

These indications shall be reported under the control of the Engineers geologist.

In order to facilitate the inspection of the excavation surfaces, the Engineer is entitled to request that these surfaces shall be cleared, washed and dried in order to enable a geologist to carry out a geological survey in the best conditions. In any case the earth filling or concreting of the excavation will not be carried out before they have been inspected and approved by the Engineer.

After his inspection the Engineer is entitled to request a deeper excavation, the earth filling or concreting shall not be carried out before another inspection has been done and the excavation approved.

4.7. Tolerances

For the excavations to be covered by concrete, or core material and adjacent filter and transition the tolerances shall be as follows: -

- for the vertical dimensions +100mm
- for the horizontal dimensions +1m

4.8. Disposal of Excavated Material

In so far as they may be suitable and comply with the Specification, materials arising from excavations may be used in the Works. All surplus or unsuitable excavated materials shall be disposed to spoil banks at proposed locations or accepted by the Engineer.

4.9. Spoil Banks

All necessary measures shall be taken not to obstruct natural drainage courses with the spoil banks

Spoil banks shall be graded to a neat appearance with outer slopes not exceeding 3H/1V. Suitable slopes shall be given to the surface to ensure drainage.

The maximum allowable height of the spoil banks shall be fixed by the Engineer.

4.10. Use of Explosives

- Permission to blasting shall only be carried out on those sections of the works for which permission in writing shall have been given by the Engineer. If blasting is necessary adjacent to any structure the Contractor shall provide a seismography and demonstrate that:
- For concrete or grout in place more than four hours but less than 60 hours, the maximum particle velocity as determined by seismographic measurement shall not exceed 10 mm/s.
- For concrete or grout in place less than four hours and greater than 60 hours, the maximum particle velocity shall not exceed 60 mm/s, except that for structures with a top width greater than their height and consisting of mass concrete or concrete having

only nominal reinforcing, maximum permissible particle velocity may be increased to 80 mm/s with approval of Engineer.

On basis of measurements obtained and on basis of observation made of structures after each blast, limits specified herein may be revised by Engineer.

4.11. Compliance with laws and regulations

The Contractor shall at all times take every possible precaution and comply with the Explosives Laws of Kenya and regulations relating to the handling, transportation, storage and use of explosives and shall at all times when engaged in blasting operations sufficient warning flagmen to the full satisfaction of the Engineer.

The Contractor shall at all times make liaison with and inform well in advance and obtain such supervision and permission as is required from the Police and all Government Authorities, public bodies and private parties whose ever concerned or affected by blasting operations.

The Contractor shall provide a special store for explosives in accordance with Kenyan Regulations. The Contractor shall provide experienced men with valid Kenyan blasting licenses for handling explosives to the satisfaction of the Engineer and the Authorities concerned.

4.12. Submittals

The Contractor shall submit to the Engineer for his approval in advance details of the intended drilling patterns, depths of holes, the amounts of explosives at each location and the method or sequence of firing that the proposes to use.

4.13. Pre-Splitting

4.13.1. General

Pre-splitting comprises drilling a line of holes of appropriate diameter, spaced on centres not more than 10 times the diameter of the drill holes diameter or 30cm whichever is the greater and charging the holes with the appropriate amount of

explosives to shear the rock in a surface along the line of drill holes. Either all holes in a pre-splitting row shall be drilled, charged and detonated simultaneously prior to drilling the production holes for the excavation adjacent to the pre-split row or pre-splitting shall be accomplished by delaying the production holes to allow the presplit holes to fire first. It is to be expected that the first row of production holes adjacent to the presplit face will need to be lightly charged to ensure that no damage occurs to the pre-sheared face when the main charge is detonated.

4.13.2. Submittals

The Contractor shall submit to the Engineer for his approval the proposed detailed methodology for presplitting.

4.14. Excavations in Quarry

4.14.1. General

Excavation of the overburden in quarry

The extent of the overburden shall be defined by the Engineer after the site investigation at the beginning of construction. Excavated material shall be sent to soil bank, or if suitable and complying with the specifications can be reused as fill.

4.14.2. Submittals

The planning of exploitation for quarry and method statement shall be submitted to the Engineer one month before starting excavations in the quarry.

4.15. Change in Quarry

When exploiting quarry, the Contractor shall perform all necessary investigations to document the quantity and quality of rock which remains to be exploited and shall inform the Engineer in writing. In case of insufficient quantities use of alternative quarry shall be contemplated.

4.16. Excavation of Earth Fill Material In Borrow Area

4.16.1. Investigations

Before opening excavations in the borrow area for earthfill, the Contractor shall perform a detailed investigation which shall include 1 exploratory pit per 10,000 m² of borrow area.

Depth of the pit shall be about 8m. Samples shall be taken every 1.5 m and subjected to the following laboratory tests in the contractor's laboratory:

- Natural moisture content
- Atterberg limits
- Grading and hydrometer
- Standard compaction test

The pits shall be logged as instructed by the Engineer and results shall be submitted to the Engineer.

4.16.2. Submittals

The earthfill borrow area planned exploitation shall be submitted to the Engineer one month before starting excavations in the borrow area.

4.16.3. Miscellaneous

- No borrow area shall be opened at less than 300m from the upstream dam toe
- The maximum slope of excavations in the borrow area located within the reservoir shall be 2.5H to 1V

4.17. Preparation of Foundations and Treatment

4.17.1. Works Included

- Preparation of foundation for intake sills
- Preparation of foundation for core and filters
- Slush grouting and dental concrete
- Preparation of foundation for concrete structures
- Preparation of foundation on soils

The excavation in sound rock will be made to a batter of 1V:0.5H, while the cut

face through weathered rock and residual soil will be sloped at 1V:1H. These relatively steep slopes will invariably require the use of shotcrete and rock dowels (or soil nailing) to stabilize the trimmed surfaces. Such treatment will not necessarily improve the stability of the overall excavation, but will protect against localized slips, surface erosion, and sloughing. Limits and details have been specified for local steep slopes, overhangs and persistent faces of the excavated foundation surface in the standard drawings.

The foundation surface will be cleaned manually using either water pressure or a mixture of compressed air and water. All loose or soft material will be removed from any cracks, crevices, joints, fractures and cavities. The jet pressure and volume of water used for cleaning will need to be carefully controlled to avoid damage during jetting. This is particularly important for sheared or weathered rocks, which are prone to damage if the water pressure is high. Care will be needed to ensure that loose deposits are not washed or blown into cracks and fissures in the rock.

After cleaning, the foundation will be offered to the site geologists for mapping. The Contractor's geologists will be required to prepare scale plans showing detailed geological mapping of the entire dam foundation. These maps will be supplemented by photographic records. Approval by the Engineer of any part of the foundation will depend on the receipt of geological mapping and photographic records.

Surface treatment of sound rock after cleaning will be limited to the filling of widely-spaced cracks and fissures with slush grout. Class C15 dental concrete will be used to fill gullies, hollows and voids in good rock.

It is inevitable that the removal of sound rock as part of the core trench, culvert and spillway excavation and shaping will result in overbreak. Class C15 backfill concrete will therefore be used to cap the entire rock surface up to the theoretical foundation level. The top of the backfill concrete will provide a suitable surface for moving the rigs used for drilling the rock anchors, and will provide a convenient base for placing reinforcement where required.

Class C20 concrete with 76 mm maximum aggregate size will be used where large volumes of concrete are required as is the case with the culverts and spillway. The surface of the concrete between backfill concrete and the culverts and spillway will be prepared as a construction joint.

4.17.2. Treatment of Surface Defects in Sound Rock

Treatment and clean-up of the foundation will be required to provide a sound, clean foundation upon which to place concrete in order to obtain a proper contact between the foundation and fill material or concrete. Various methods of treatment and clean-up are expected. It is expected that careful cleanup by hand using high pressure air and water, or just air, will be necessary to provide a reasonably tight foundation free from loose rock and broken down weathered rock particles. All joints and seams wider than 50 mm will be gouged out to a depth equal to three times their width, and backfilled with shotcrete or concrete. Joints and seams narrower than 50 mm will be treated by hand filling with sand-cement grout.

Gradual undulations in the foundation surface are acceptable; however, any abrupt changes in the foundation surface shall be removed either by trimming or backfill concrete. Steep or overhanging rock faces shall be cut back to a short continuous face, or a series of stepped faces, to provide satisfactory abutment contact slopes of the embankment. Such rock faces shall, in general, be cut back to slopes of 1:1 or flatter. Where it is not possible or desirable to meet these requirements the rock shall be solidly faced with backfill concrete to provide abutment contact slopes not steeper than 0.75 horizontal to 1 vertical.

4.17.3. Control of Water in Foundation for Core and Filters

- A spring encountered in prepared foundation be reported to the Engineer.
- No placement of compacted fill for core, filters or transition shall be performed in water.
- In case of springs or other water ingress, the Contractor shall pump into sumps protected with pipes such as to obtain a dry excavation bottom. After having constructed the first metres of backfill, the sumps and their protection pipes shall be carefully grouted

Preparation of Foundation for Concrete Structures

- In principle the intake, tower, the culvert, the downstream valve chamber and the wholespillway shall be mainly founded on soft rock (pumice tuff).
- As for the core and filter of the embankment dam, the foundation preparation shall be carried out in two phases.

First phase

The rock loosened by blasting (or ripper if ripping appears possible) shall be prepared with jackhammer or any other way to obtain the best possible surface state.

Then the rock surface shall be cleaned of all loose or otherwise unsuitable materials by hand and compressed air.

As it is considered that the pumice tuff and agglomerates are likely to deteriorate and develop crack under drying wetting cycles a cover of 2 mm of unexcavated materials shall be left on these rocks with respect to final excavation depth.

In the spill-weir area, the ham grout curtain shall be constructed

after this stage. Second phase

Just before performing concreting, the remaining rock cover shall be excavated with jack

hammers and hand picks. Cracks and fractures shall be cleaned and grout spillage chipped out. Finally, the surface shall be cleaned with compressed air jets and brushes. If necessary, cavities shall be filled with dental concrete and slush grout shall be used locally as directed by the Engineer.

4.18. Other Compacted Fill

4.18.1. Material

The other compacted fill (cofferdams spillway chute, downstream valve chamber, downstream part of the culvert, etc) shall be approved "red clay" from the borrow area or from the excavation. It shall fulfill the grading and Atterberg limit requirements given in section 4.17.

4.18.2. Spreading and compaction

Same requirements as in section 4.17.2,

4.18.3. Compaction control

a. Regulation control

Using the same symbols as in 4.17.3

Placement moisture content

$$-2 < W - W_{opt} < +2$$

Dry density

$$DC = Y_d / Y_{max} > 95\%$$

b. Method of control

In situ density + amended USBR E25 + undrained shear strength with vane test.

c. Frequency of control

In no. control

for 1,000m

4.19. Dumped Red Area

4.19.1. Material and grading

Dumped red clays shall be used as watertight element upstream the pre-cofferdam as shown in drawing 207.

The material shall be approved red clays from the borrow area or from the excavation. It shall fulfill the grading and Atterberg limits requirements given in section 4.2.3.1 but shall be dry with respect to optimum (lower part of the borrow areas) so as to contain chunks.

4.19.2. Placing

The selected material shall be pushed down with the blade of the bulldozer operating parallel to the pre-cofferdam slope.

4.20. Filters and Transitions

4.20.1. Geotextile material

The Geotextile fabric material is to be used in the construction of drainage blanket and vertical sloping filters and shall meet the following minimum characteristics:

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- Manufactured with polyester fiber
- Non-woven needle punched randomly oriented mat of continuously and stabled fibre compacted and mechanically entangled by multiple piercing with barbed needles fleece held together by entanglement
- Weight not less than 0.3kg/m²
- fabric lapped not less than 15cm
- tensile strength (KN/m²) – 50
- coefficient of permeability (m/s) – 0.4

4.20.2. Materials

Filters F1, F2 and transition T1 shall consist of hard durable crushed rock or natural sand and gravels derived from sources approved by the Engineer.

The filters F1-F2 and transition T1 shall comply with the grading requirements quoted below. These gradings should remain fulfilled after handling, placing and compaction and shall be controlled on the stockpile and after compaction.

Material size In millimetres (square openings)	Percent finer than by weight	
	Filter F1	Filter P2
50	1	100
20	100	90-100
10	-	60-100
5	95-100	15-60
2	70-100	0-5
1	40-80	-
0.5	15-50	-
0.2	0-5	-
0.075	0.30-	
0.075	2-15	-

Material size In millimetres (square openings)	Percent finer than by weight
	Transition T1
100	100
50	80-100
20	55-80
5	35-60
1	10-35
0.075	2-15

In addition, the material shall meet the following test requirements:

- Los Angeles abrasion test not to exceed 45% by mass

- Water absorption not to exceed 7%

4.20.3.Placing and Compaction

Transition and filters upstream and downstream the core shall be placed in approximately horizontal layers in the range 250-400mm compacted thickness depending on the finally selected lift thickness for the core.

Filters and transition placed on dam foundation shall be placed in layers not exceeding 250 mm compacted thickness.

Each layer (on the foundation or upstream/downstream the core) shall be compacted by means of a vibrating smooth drum roller so as to achieve a relative density in the range 70% - 80%. The relative density shall be determined by the USBR Method Designation E12.

If necessary to achieve the compaction requirement, filters shall be wetted. For the filter box the relative density shall be larger than 80% and the material shall be wetted.

Care shall be taken not to pollute filters and transitions with earthfill. Any polluted filter or transition shall be replaced.

4.20.4.Controls

Final acceptance of filters and transition shall only be made after materials above have been dumped, spread and compacted.

4.21. Compacted Rockfill

4.21.1 Material

a. Basic solution

In the basic solution, two types of compacted rockfill are used in the embankment dam: Rockfill R1 and Rockfill R2. They shall consist of hard durable rock from nearby quarry or other approved quarry or from the excavations in case suitable material would be encountered.

They shall be reasonably well graded within the limits shown quoted below.

Material size In millimetres		Percent finer than by weight	
Square opening	Circular opening	Rockfill R1	Rockfill R2
600	750	100	100
200	250	70-100	100
300	125	-	100
100		50-90	50-90
50		30-75	35-75
20		10-50	10-50
10		0-35	0-35
5		0-25	0-25
2		0-15	0-15
1		0-10	0-10
0.075		0-5	0-5

In addition, the material shall meet the following test requirements:

- Los Angeles abrasion test not to exceed 55% by mass
- Unconfined compressive strength larger than 18MPa
- Specific gravity:
 - OD larger than 2.30
 - SSD larger than 2.40
 - APP larger than 2.65

b. Alternative

Rockfill R5 should be reasonably well graded within the limits shown on drawings and quoted below: -

Square opening	Circular opening	Rockfill R1
600	750	100
200	250	70-100
100	175	55-100
50		40-80
20		20-60
2		15-40
0.075 (hydrometer)		5-25

c. For rockfills R1, R2 and if necessary R5.

The Contractor shall perform all processing needed to obtain rockfills which meet specified requirements. Such processing shall, where necessary, include separating material with one another, where blending is required, materials shall be thoroughly mixed in such a manner that a homogeneous fill of specified gradation is achieved prior to placing of material into work or stockpiles.

Contractor's processing plant and methods will be subject to Engineer's approval, Processing plant shall be capable of producing rockfill at a rate satisfactory for meeting scheduling requirements. Processing shall be done in an area approved by Engineer.

The maximum lift thickness for rockfill R1, R2 and R5 shall be 0.80 m. Placing shall be performed so as to obtain homogeneous fill without segregation. The rockfill shall be dumped on top of the new layer, back from the advancing edge on the lower layer with bulldozer blades

- Any other size particle which protrudes from the layers shall be removed before compaction.
- Moistening of the rockfills shall be performed to the extent necessary to achieve the best compaction as demonstrated in the test embankment.

Compaction

Compaction of rockfill shall be performed with an approved single or double smooth drum vibrating roller with the following characteristics:

- minimum static weight - 10t
- drum diameter - not less than 1500mm
- maximum drum length 2200mm
- minimum static weight per m of drum 4.5
- minimum total applied compacting force at rated
- vibration frequency 30

Roller shall travel at speeds not to exceed 4 km/h.

The number of passes shall be in the range 4 to 6, the construction value being selected based on the trial embankment result.

Controls

Final acceptance of rockfills shall only be made after materials have been dumped, spread and compacted in place. Rejection by Engineer may be made at source, on transporting vehicle, or in place. Contractors shall co-operate with Engineer to ensure that only acceptable rockfill materials will be hauled from source to works.

In the alternative, in case rockfill R5 would, in the Engineer's opinion develop construction pore pressures, Horizontal strips of rockfill R1 (and paid as R1) would be laid as directed by the Engineer. In the alternative. In situ permeability test in rockfill R5 shall be performed.

4.21. Riprap R3 and R4

4.21.1. Material

Riprap R3 (upstream slope protection of the dam) and R4 (spillway downstream protection) shall be obtained from quarry nearby or other approved sources.

Grading shall be within the limits shown below:

Material size in millimetres		Percent finer than (by weight)	
Square opening	Circular opening	Rockfill R3	Rockfill R4
600	750	100	
500	625	70-100	100
400	500	40-60	100-0
300	375	0-20	0
200	250	0	

In addition rock shall meet the following test requirements:

- Los Angeles abrasion test not to exceed 40% by mass
- Unconfined compression strength larger than 25 MPa
- Specific gravity:
 - o OD larger than 2.40
 - o SSD larger than 2.50
 - o APP larger than 2.70
- Water absorption smaller than 5%

4.22.1 Placing

Riprap need not be compacted but shall be placed carefully in such manner that larger rock fragments are uniformly distributed and small rock fragment fill voids between larger pieces. Hand placing will be required to extent necessary to secure results specified above. The specifications as to rock size and grading specified herein, shall apply to riprap in place. Riprap shall be placed simultaneously with embankment construction so that a minimal of breakdown

will occur during placing and spreading, and shall be placed in lifts not exceeding 1.5 m in width parallel to slope.

4.22.2 Controls

Final acceptance of riprap will only be made after materials above had been placed. Rejection by Engineer may be made at source, on transporting vehicle, or in place, Contractor shall cooperate with Engineer to ensure that only acceptable riprap materials will be hauled from source to work.

4.22. Roads

4.22.1. General

The Contractor shall construct and maintain the permanent roads comprising the embankment crest road, the access roads on the gravel surfacing on platforms and backfill as shown on the drawings. These permanent access roads are used by the Contractor for access during construction. The Contractor shall reinstate to the satisfaction of the Engineer gravel surfacing to the thickness grade and crossfall as shown required.

4.22.2. Subbase

The sub base material for access road shall be approved material compacted to 150 mm thickness at 95% of modified Proctor maximum density.

The sub base material shall comply with the following grading requirement:

- - 100% by weight passing 50 mm sieve (square mesh),
- - 75-85% by weight passing 20mm sieve (square mesh),
- - 40 – 50% by weight passing 5mm sieve (square mesh)

Before placing the sub base, the foundation shall be scarified and recompacted.

4.22.3. Gravel Surfacing

The gravel surfacing for access roads, embankment crest road, backfill and platforms protection shall be 200 mm average thickness of approved gravel rolled to a smooth even surface.

The term "gravel" used shall be any such material which might be specified for use as a wearing course, e.g. murrum, some forms of partly decomposed rock or crushed rock.

Gravel surfacing material shall be spread in a uniform layer across the full width required, spread so that the maximum size of any particle is not greater than one half the compacted thickness of the layer. It shall then be mixed, watered if directed by the Engineer, graded and compacted by at least 6 complete passes of a 10 tonne smooth wheeled roller or other equivalent and graded to final level.

The tolerances on level permitted in the final surface of the wearing course will be:

	Variations permitted		Camber
	Thickness	3 m straight edge	
Gravel wearing Course	25 mm	25 mm	25 mm

4.24. Trench Excavations

4.24.1 Timbering of Excavations

The Contractor shall supply and fix outside the limits of the permanent Works all the timber necessary for support of sides and bottoms of the excavations, for the security of adjacent structures and properties and for every other purpose for which it may be required, all to the satisfaction of the Engineer. The Contractor shall maintain such supports until in the opinion of the Engineer, the works is sufficiently advanced to permit the withdrawal of the support. Such withdrawal shall be executed only under the personal supervision of a competent foreman.

The Engineer may order excavations to be timbered or to be close timbered or may order timbering to be driven ahead of the excavation, or may order the adoption of any other method of supporting the sides and bottoms of the excavations as may appear to be necessary, and the Contractor shall adopt and shall make no charge for executing the adopted method.

The Contractor shall be responsible for any injury to the workers and any consequential damage caused by or arising out of the insufficiency or the support he provides for his excavations or caused by or arising out of the removal of that support, and any advice, permission, approval or instruction given by the Engineer relative to that support or removal thereof shall not relieve the Contractor of his responsibility.

For the purpose of this Clause the words "timber" and "timbering" shall be construed to include trench sheeting and steel or concrete sheet piling or any other means adopted by the Contractor for supporting excavations. All the costs for compliance with the provisions of this clause shall be deemed to have been included in the Contractor's rate for excavation

4.25. Excavation to be Kept Free from Water

Where excavations are required below the existing water level, the Contractor shall make arrangements to keep the excavation dry and shall produce drawings and written explanations of the method to be used to enable the Engineer to determine the adequacy of the method, before commencing the excavation.

The Contractor shall give due regard to the possibility of floods and provide all pumps, timbering, coffer dams, sheet piling and other equipment necessary for keeping the excavations free from water.

Every precaution shall be taken not to diminish the bearing capacity of the soil below foundation level. Wall-points or pump pits are to be outside the foundation area to prevent flows in upward direction.

All sumps and drains are to be filled in or otherwise made good as directed by the Engineer on completion of the relevant part of the Works.

The costs of all the above precautions shall be at the contractor's expense.

4.26. Excavation in Hard Material

Where hard material is encountered in trenches for pipe lines it shall be excavated so that no hard material protrudes within 100mm of the pipe surface. A regulating layer of 150mm sand or other approved material shall be placed on the excavated hard material surface to provide a firm but flexible bed for the pipe.

The Contractor shall notify the Engineer on each occasion when he encounters hard material prior to excavation of such materials. No payment for excavation in hard material shall be made unless the Engineer has inspected the excavation and certified in writing that the material meets the classification of hard material and the quantities involved.

The Contractor shall trim all rock faces in cutting to accord with the dimensions shown on the drawings and upon completion leave them safe from rock falls to the satisfaction of the Engineer.

The Contractor's blasting and other operations in excavation shall be such that they will yield as much suitable material as possible for the construction.

4.27. Foundation for Structures

4.27.1 Soft material:

The bottom and side slope of soft material upon or against which concrete is to be placed shall be finished accurately to the established lines and grades, and loose materials on surfaces so prepared shall be moistened with water and tamped or rolled with suitable tools and equipment to form a firm foundation for the concrete structure. If, at any point in soft material, material is excavated beyond the established excavation lines, for any reason except by written orders from the Engineer, then the over-excavation resulting voids shall be filled with concrete class 15 at the Contractor's expense.

4.27.2 Hard Materials:

The bottom and side slopes of hard material upon or against which concrete is to be placed shall be excavated to the required dimensions as shown on the drawings or established by the Engineer. No material will be permitted to extend within the neat lines of the structure. If, at any point in the hard material, material is excavated beyond the limits required to receive the structure, the additional excavation shall be filled solidly with concrete class 15.

All loose material shall be removed by the use of steel brooms and air jets.

4.28. Trench Excavations

The width of the trench to be excavated will depend on the size and type of pipe being laid. Sufficient width must be excavated to allow the pipe to be correctly bedded and aligned, and to allow for the joints to be correctly made. Generally the grade of the pipe will conform to the lie of the ground, but the excavation must be deepened where necessary to avoid backfills in any section. Generally the pipeline will slope down towards scour valves and up towards air valves. Minimum gradients are shown on the general drawings.

Width of excavations for trenches for all pipes shall be determined from the following formula $W = nD + (n-1)0.3 + 0.6$

Where:

W = width of the trench to be excavated
n = number of pipes

D = external diameter of the pipe

Trench excavation shall be carried out with great care, true to line and gradient and as near as practicable to the size required for construction of the permanent work.

Excavation for pipe trenches shall be of sufficient depth to give a minimum cover of 900 mm over the top of the pipe and 1.2 below the road crossings.

Where the pipeline is required to be laid at depth, which does not satisfy the minimum cover conditions set out above, the ground surface shall be brought up to the required level by banking the backfill or as directed by the Engineer.

4.28.1. Backfilling with Excavated Suitable Material

No backfilling or refilling shall commence without the Engineer's approval.

The refilling of excavations shall commence as soon as practicable after the permanent work has been tested where so required and inspected and approved by the Engineer. In particular the backfilling of trenches shall be carried out expeditiously to reduce lengths of trenches open at any one time.

As soon as High Density Polythene pipes are laid and jointed in their final positions they should be protected from possible damage by carefully backfilling of fine granular material brought up to about 150 mm over the top of the pipe, for the full width of the trench, and well compacted.

Joints must be left open for inspection until the pressure test is completed.

Backfilling shall be executed with suitable excavated material in 150 mm layers each layer being well rammed and watered to obtain the maximum compaction. Care shall be taken to ensure that no stone or other material, which could damage pipes or other work.

Water in excess shall not be used in settling of the backfilling.

Backfilling over steel pipes shall be generally as described above, except that the initial protective filling around the pipe is not necessary.

Regardless of the means of backfilling adopted, it is the Contractor's responsibility to ensure that he satisfactorily backfills all excavations and causes no damage to permanent work or adjacent structures, and he shall at his own expense take all steps necessary to comply with this obligation.

The Contractor shall at all times be responsible for damage caused to permanent works through his backfilling operations or through the premature opening to traffic of a backfilled surface.

The minimum cover, where pipelines cross under roads, shall be 1.2 m to the top of the surrounding concrete, or such cover as may be directed by the road authorities.

Any excavated material stored on site for backfilling or other purposes shall be deposited alongside the excavation at a minimum distance of 0.5 m in such a manner that it will cause no damage and as little inconvenience as possible.

The rate for excavation shall include the costs of complying with the requirements of this clause.

4.29. Backfilling with sand or imported suitable material

Where shown in the drawings or instructed by the engineer, the Contractor shall provide and use approved sand or imported suitable material to backfill around pipes and structures to the thickness instructed by the Engineer. A rate in the Bill of Quantities shall be provided for this item.

4.30. Reinstatement of Surfaces

Generally, all trenches and backfilled excavations shall be reinstated to equal surface as before excavation.

Trenches in any existing road shall be refilled to the level of natural soil below the road with sub-soil in 75 mm layers, each layer being carefully tamped with rammers. The remaining top layers shall be filled to the road surface with materials equal in type, quantity and compaction to materials used for the existing road.

The backfilled trench shall then be left to settle for 30 days. At the expiration of this period the surface shall be made up to level and tamped or rolled to the approval of the Engineer, who will decide on the particular surfacing employed in accordance with the existing surface of the road.

Before expiration of the maintenance period the Contractor shall make good any defaults in reinstatement. The rate for excavation shall include the costs of complying with the requirements of this clause.

4.31. Removal of Surplus Excavated Material

Excavated material, which is not needed either for backfilling trenches or other excavations or otherwise, shall be removed and disposed off to tipping places obtained by the Contractor. All rubbish and waste material shall similarly be removed by the Contractor. All surplus excavated material shall be spread and leveled in the tipping places in accordance with such directions as the Engineer may give, and the Contractor's rates for disposal shall include for the costs of such operations.

The Contractor shall take every practical precaution against causing any nuisance, damage, injury or inconvenience in the handling, stacking, carting or disposal of excavated materials or any other operation matter or thing in connection therewith. No excavated material shall be placed in any position where it may be washed away or may be liable to fall or spread into any private property or across a road or footpath, and should such occur, the Contractor shall forthwith remove the same at his own costs.

Should the Engineer direct the Contractor to tip certain surplus excavated materials in a particular place (other than the tipping places obtained by the Contractor) the Contractor shall abide by such instruction and shall make no charge in consequence thereof unless the place specified entails a longer haul than what would be incurred by tipping at the place or places obtained by the Contractor.

The rate for excavation shall include the costs of complying with the requirements of this clause.

4.32. Borrow Pits

No borrow pits will be allowed to be opened within the site of permanent works without the approval of the Engineer.

No separate payment will be made for acquisition, development and operating borrow sites whatsoever as the same is deemed to have been included in the Contractors rates.

All borrow sites will have to comply with national and local laws and regulations governing operations of such borrow sites. The Engineer reserves the right to order closure and reinstatement of any borrow site that might prove harmful to the public.

4.33. Rock Fill below Structures

Where shown in the drawings or instructed by the Engineer, the Contractor shall provide and place rockfill below structures. Rockfill shall consist of clean hard broken stone or rubble with measurements not exceeding 150 mm in any one direction with sufficient lateritic gravel added to fill the interstices. The Rockfill shall be well-packed, rammed and where possible rolled with a 5 ton roller. Where rolling is impossible, compaction shall be by hand or by mechanical tampers. Before any concrete is laid on Rockfill, the rockfill shall be levelled and blinded with fine stone chippings, rolled and watered as necessary. The volume of rockfill shall be measured after compaction. A rate in the Bill of Quantities shall be provided for this item.

4.34. Grass Planting and Top Soil

Top soil shall be selected vegetable soil, well compacted and except where otherwise specified be of 150 mm thickness.

The Contractor shall trim the faces of the side slopes to open channels and elsewhere where directed to the dimensions, inclinations and curves shown on the Drawings, remove all excess material and make good all depressions with suitable material.

Where instructed by the Engineer, the Contractor shall plant locally available species of grass or as approved by the Engineer at the rate of 16 plants per m² corresponding to 250 mm c/c. The Engineer shall satisfy himself that natural growth of grass will not take place within a reasonable time before instructing the Contractor to grass specified areas.

The Contractor shall be responsible for obtaining suitable grass plants and for making all necessary arrangements with the owners and/or occupiers of the land from which they are to be obtained. The Contractor shall be responsible for the preparation of the surface for planting, and for maintaining adequate grass cover and necessary watering during the Contract and Maintenance Period.

The Contractor shall be required to rehabilitate all spoil areas at his own cost to the satisfaction of the Engineer.

A rate in the Bill of Quantities shall be provided for this item.

4.35. Ant-Proofing

Where an ant-proof course has been specified or instructed by the engineer, it should be made by application of Rentokil Termite Soil Concentrate or equal diluted one part concentrate to forty parts water (by weight) at the rate of 5 litres solution

to 1 square meter to the whole area of the structure immediately before (36 hours maximum) the concrete is poured. Additionally to all critical areas, i.e. both sides of wall foundations, piers and porches the application should be 5 litres per running metre. Treatment should not be made when the soil is excessively wet. Precautions should be taken to prevent disturbance of the treated areas before they are covered.

4.36. Stone Pitching

Where shown on the Drawings. Or directed by the Engineer the Contractor shall excavate for, trim to line and level, provide and lay stone pitching.

Stone pitching shall be formed of hard stone, roughly dressed square.

The least dimension of any stone shall not be less than 200 mm, and the volume not less than

0.01 m³. No rounded boulders shall be used.

The stones shall be set on edge and securely bedded with the largest dimensions at right angle to the flow of water, fitted closely together so as to leave only a minimum of voids between the stones which shall be filled in with suitably shaped and tightly wedged spalls. The top of the pitching shall be finished flush with the adjacent material.

Where grout is specified, a 1:4 cement: sand mortar shall be rammed into the wetted interstices and smoothed off flush with the pitched face.

4.37. Gabions

Where shown on the Drawings or directed by the Engineer the Contractor shall excavate for, trim to line and level, provide and erect gabions including providing selected rock, crushed if necessary, packed and compacted inside the gabions.

Gabions shall include gabion mattresses and gabion boxes and for the purposes of construction and method of measurement and payment no distinction shall be made between them.

Gabions shall be "Maccaferri" boxes and/or "Reno" mattresses both with diaphragms at 1 metre centres, or similar approved. The maximum mesh size shall be 100 mm x 120 mm for boxes and 60 mm x 80 mm for mattresses. The wire used for the construction of gabions shall unless otherwise instructed by the Engineer comply with the requirements of Table 4-1.

		Diameter (mm)	Galvanising (g/m ²)
Mesh	Box	3.4	275
	Mattress	2.7	260
Binder	Box	2.2	240
	Mattress	2.2	240
Selvedge	Box	3.9	290
	Mattress	3.4	275

All wire shall be to BS 1052 having a tensile strength of not less than 40kg/mm² Galvanizing shall comply with the requirements of BS 443.

Gabions shall be constructed to the shapes and dimensions as shown on the Drawings or given in the Special Specification or as directed by the Engineer. Gabions, as constructed shall be within a tolerance of +/- 5% on the height or width instructed and + / -3% on the length instructed.

The alignment of the gabion shall be correct within a tolerance of 100mm of the instructed alignment and the level of any course of gabion shall be correct to within a tolerance of 50mm of the instructed level. In addition adjacent gabions shall not vary by more than 25mm in line and/or level from each other

The surface upon which gabions are to be laid shall be compacted to a minimum dry density of 95% MDD (AASHTO T99) and trimmed to the specified level or shape.

Joints in gabions shall be stitched together with 600mm minimum lengths of binder wire, with at least one stitch per 50mm, and each end of the wire shall be fixed with at least two turns upon itself.

Adjacent gabions shall be stitched together -with binder wire along all touching edges.

Gabion boxes shall be laid with broken bond throughout to avoid continuous joints both horizontally and vertically. Pre-tensioning of gabions shall be subject to the approval of the Engineer.

Gabions shall be hand packed with broken rock of 150 mm minimum dimension and 300mm maximum dimension. The sides shall be packed first in the form of a wall, using the largest pieces, with the majority placed as headers with broken joints to present a neat outside face. The interior of the gabion shall be hand packed with smaller pieces and the top layers shall be finished off with larger pieces. The whole interior and to layers shall be packed tight and hammered into place.

Where instructed by the Engineer the Contractor shall place filter fabric ('Terrain' or similar approved) behind gabion faces in contact with existing or backfilled ground. The Contractor shall ensure that the filter fabric is not damaged during the construction or backfilling around the gabion works and any damaged or torn fabric shall be replaced at the Contractor's expense. The filter fabric shall be installed in accordance with the manufacturer's instructions and the filter fabric shall not be left exposed to sunlight for more than 3 weeks.

At the back face and ends of completed gabion work or where shown on the Drawings or instructed by the Engineer the existing soil shall be backfilled, thoroughly compacted against the sides of the gabions and finished flush with the top surface of the gabion.

On completion of gabion construction the exposed joints shall be painted with thick bitumen to the approval of the Engineer to discourage vandalism

4.38. Measurement and Payments

a. Clause 4.3: Excavation in Soft material

I) Excavation for trenches in

Soft Material Unit:., m³

Excavation for trenches in soft material shall be measured in cubic meters calculated as the product of the width of the excavation given in clause 4.6 of this specification and the sectional area. The sectional area of the excavation, measured in square meters shall be calculated by the product of the average depth of the excavation and the instructed length of the trench. The average depth shall be measured from the instructed final profile.

The rate for excavation in trenches in soft material shall include for the cost of excavation to any depth, trimming and levelling, backfilling with excavated material or removal of excavated material to spoil if it is unsuitable or surplus to requirements, and complying with the requirements of clauses 4.3.1, 4.3.2, 4.3.3, 4.6, 4.7, 4.9 and 4.10 of this specification.

II) Excavation for Structures in

Soft Material Unit:., m³

Excavation for structure in soft material shall be measured by the cubic meter, calculated as the product of the net plan area of the foundation to be excavated and the average depth of the excavation. No allowance will be made for working space. The average depth shall be calculated as the difference between the original ground level as agreed in clause 1.26 of this specification between the engineer and the contractor, and the required level.

The rate for excavation for Structure in soft material shall include for the cost of excavation to any depth, Compaction of the foundation level of the excavation, backfilling with excavated material or removing the excavated material to spoil if it is unsuitable or surplus to requirements, and complying with the requirements of clauses 4.3.1, 4.3.2, 4.3.3, 4.7, 4.9 and 4.10 of this specification.

b. Clause 4.4: Excavation in

Hard Material Unit: m³

Hard material encountered in any excavation shall be measured by the cubic meter, calculated

as the product of the average end area measured at intervals agreed with the engineer along the centreline of the excavation. No allowance will be made for working space.

The rate for excavation in hard material shall include for the cost of excavation to any depth, Compaction of the foundation level of the excavation or trimming and levelling, backfilling with excavated material or removing the excavated material to spoil if it is unsuitable or surplus to requirements, and complying with the requirements of clauses 4.3.1, 4.3.2, 4.3.3, 4.4, 4.5, 4.6, 4.7, 4.9 and 4.10 of this specification.

c. Clause 4.7 Backfilling with sand or imported suitable material. Unit m³

Sand or imported suitable material shall be measured by the cubic meter, calculated as the product of the average end area (excluding any pipe or concrete surround) and the length of the suitable backfill material instructed to be placed.

The rate for suitable backfill material shall include for the cost of providing the material, backfilling at any depth, all the hauls as necessary and complying with the requirements of clauses 4.7 and 4.8 of this specification.

d. Clause 4.11: Rock fill below

Structures Unit: m³

Hard-core filling shall be measured by cubic metre calculated as plan area and average depth of hard-core fill instructed.

The rate for hard-core filling shall include for the cost of providing, placing the material, compacting, all the hauls as necessary and complying with the requirements of clauses 4.12 of this specification.

e. Clause 4.12 Grass planting and top soil placing Unit: m²

Grass planting and top soil placing shall be measured as plan area in square meters instructed.

The rate for grass planting and top soil placing shall include for the cost of providing grass and suitable top soil, placing, planting, watering, all the hauls as necessary and complying with the requirements of clauses 4.13 of this specification

f. Clause 4.13 Item: Ant Proofing

Unit: m²

Ant proofing shall be measured as **plan** area in square meters instructed.

The rate for ant proofing shall include for the cost of providing, placing, and complying with the requirements of clauses 4.14 of this specification

g. Clause 4.14 Item:

Stone pitching Unit: m²

Stone pitching shall be measured by the square metre calculated as the net area, measured on the slope, instructed by the Engineer.

The rate for stone pitching shall include for the cost of excavating, trimming to line and level, grouting, providing and laying the stone and of complying with the requirements of clause 4.16 of this specification. Grouting of stone pitching shall include for providing the sand, cement, mortar, wetting of the stone to be grouted, ramming the grout into the interstices and smoothing off: flush with the pitched face and complying with Clause 4.16 of this Specification.

h. Clause 4.15 Item: Gabion Boxes

Unit : No.

Gabion boxes shall be measured by the Numbers calculated as the net area of material required to construct the gabions, including diaphragms.

The rate for gabion mesh shall include for

- a. the cost of providing and fixing the mesh and the cost of complying with requirements of Clause 4.15 of this Specification.
- b. the cost of excavation to any depth, compaction of the surfaces to receive the gabions, backfilling with the excavated material or removing the excavated material to spoil if surplus to requirements, and complying with the requirements of other Clauses in section 4 of this Specification.
- c. the cost of providing, hauling and placing the rock and the cost of complying with the equipments of Clause 4.15 of this Specification.

i. Item: Filter fabric under and/or

behind gabions Unit: m of each weight

a fabric specified

The filter fabric placed under and/or behind gabions shall be measured as the net area of filter fabric instructed.

The rate for filter fabric shall include for the cost of the preparation of the surface to receive the filter fabric, the provision, transport, storing and laying the fabric in accordance with the manufacturer's instructions, all laps and/or stitching and for complying with the requirements of Clause 4.15 of this Specification.

5. CONCRETE WORKS

5.1 General

All materials and workmanship for concrete shall comply with BS EN 206: 2000- Specifications; BS EN 1992 1-1: Design of Concrete Structures; Part 1-1: General Rules and Rules for Buildings, BS 1992-3:2006-Design of Concrete Structures. Liquid retaining and containing; where applicable.

This section covers the materials, design of mixes, mixing, transport, placing, compaction and curing of concrete and mortar required in the works. It also covers formwork and reinforcement for concrete.

5.2. 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.

5.3. Materials for Concrete

5.3.1. 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.

5.3.2. Cement

Cement shall comply with the following Kenya Standards: -

- KS 1725: 2001 CEM 1 42.5N for Ordinary Portland Cement
- KS 02-21: for Rapid Hardening Portland Cement plus all special conditions to its use stipulated by the manufacturer

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 provided with effective means of ensuring that it is protected from the weather.

Bulk Cement shall be transported in vehicles or in containers 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 m 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 anyway shall be removed from the Site.

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

All cement used in the works shall be tested by the manufacturer or the Contractor in a laboratory acceptable to the Engineer. The tests to be performed shall be those set out in Section 2 of this Specification and the Contractor shall supply two copies of each certificate to the Engineer.

Each set of tests carried out by the manufacturer or Contractor shall relate to not more than one day's output of each cement plant, and shall be made on samples taken from cement which is subsequently delivered to the Site. Alternatively, subject to the agreement of the Engineer, the frequency of testing shall be one set of tests for every 200 tonnes of cement delivered to Site from each cement plant.

Cement which is stored on Site for longer than one month shall be re-tested in the laboratory of the Materials Branch of the Ministry of Transport and Communications or at the Kenya Bureau of Standards at the rate instructed by the Engineer.

Cement which does not comply with the Specification shall not be used in Works and it shall be disposed of by the Contractor.

The Contractor shall keep full records of all data relevant to the manufacture, delivery, testing and use of all cement used in the Works and shall provide the Engineer with two copies thereof.

5.3.3. 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 12620:2002 +A1:2008. All the material shall pass through a 5 mm BS sieve and the grading shall be in accordance with Zones 1, 2 or 3 of BS EN 12620:2002

+A1:2008. 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 EN 13139:2002-Aggregates for Mortar.

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 British Standard 1881, that the presence of such materials does not adversely affect the properties of the concrete.

Other properties shall be as set out below:

Content passing a 75 micron BS sieve shall not exceed 3 per cent for natural or crushed gravel sand or 15 per cent for crushed rock sand.

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.05 per cent by weight expressed as chloride ion when tested as set out in BS 932-1:1997 (Tests for general properties of Aggregates. Methods for Sampling), subject also to the further restriction given in the note on total chloride content.

Sulphates soluble in a 10 per cent solution by weight of hydrochloric acid shall not exceed 0.4 per cent by weight expressed as SO₃, when tested as set out in BS 1377-1: 2016 (Methods of test for Soils for Civil Engineering purposes), subject also to the further restriction given in the note on total sulphate content in Sub-Clause 5.4 (d).

Soundness: After five cycles of the test in AASHTO T104 the aggregate shall not show a weight loss of more than 10 per cent.

Organic impurities: If the test described in Section 2 of this standard Specification shows that more than a trace of organic impurities is present, the fine aggregate shall not be used in the Works unless the Contractor can show by tests on finished concrete as set out in BS 1881 that the presence of organic impurities does not adversely affect the properties of the concrete.

5.3.4. Coarse Aggregate

Coarse aggregate shall be clean hard and durable crushed rock, crushed gravel or natural gravel complying with the requirements of BS EN 12620:2002 +A1:2008. 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 1881 that the presence of such material does not adversely affect the properties of the concrete. The pieces shall be angular rounded or irregular as defined in BS EN 12620:2002 +A1:2008.

Coarse aggregate shall be supplied in the nominal sizes called for in the contract and shall be graded in accordance with BS 932-1:1997 (Tests for general properties of Aggregates. Methods for Sampling) for each nominal size.

Other properties shall be as set out below: -

The proportion of clay, silt and other impurities passing a 75 micron BS sieve shall be not more than one per cent by weight.

The content of hollow and flat shells shall not be such as will adversely affect the concrete quality when tested as set out in BS 1881. The total shell content of aggregate shall not be more than the following:

40 mm nominal size and above	2% of dry weight
20 mm nominal size	5% of dry weight
10 mm nominal size	15% of dry weight

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.03 per cent by weight, expressed as chloride ion when tested as set out BS 932-1:1997 (Tests for general properties of Aggregates. Methods for Sampling) but subject also to the further restriction under the note on total chloride content hereunder. Sulphates soluble in a 10 per cent solution by weight of hydrochloric acid shall not exceed 0.4 per cent by weight expressed as SO₃ when tested as set out in BS 1377 subject also to the further restriction given in the note on total sulphate content hereunder.

Soundness: After 5 cycles of the test in AASHTO T104, the aggregate shall not show a weight loss of more than 12 per cent.

When tested in accordance with test C289 of the American Society for Testing and Materials, the aggregate shall be non-reactive.

Flakiness Index when tested in accordance with BS 812 shall be as set out hereunder :- For 40 mm stone and above, not more than 40

For 20 mm stone and below, not more than 35

5.3.5. Testing aggregates

5.2.1.1. Acceptance testing

The Contractor shall deliver to the Engineer samples containing not less than 50 kg of any aggregate which he proposes to use in the Works and shall supply such further samples as the Engineer may require. Each sample shall be clearly labeled to show its origin and shall be accompanied by all the information called for in BS EN 12620:2002 +A1:2008.

Tests to determine compliance of the aggregates with the requirements of Sub-Clause 5.4 (c) and (d) shall be carried out by the Contractor in a laboratory acceptable to the Engineer. If the tested materials fail to comply with the Specification, further tests shall be made in the presence of the Contractor and the Engineer and acceptance of the material shall be based on such tests.

A material shall be accepted if not less than three consecutive sets of test results show compliance with the Specification.

5.2.1.2. Compliance testing

The Contractor shall carry out routine testing of aggregates for compliance with the Specification during the period that concrete is being produced for the Works. The tests set out below shall be performed on aggregates from each separate source on the basis of one set of tests for each day on which aggregates are delivered to Site provided that no set of tests shall represent more than 250 tonnes of fine aggregate nor more than 500 tonnes of coarse aggregate, and provided also that the aggregates are of uniform quality. If the aggregate from any source is variable, the frequency of testing shall be increased as instructed by the Engineer.

Grading	932-1:1997 (Tests for general properties of Aggregates. Methods for Sampling)
Silt and clay contents	932-1:1997 (Tests for general properties of Aggregates. Methods for Sampling)
Moisture content	932-1:1997 (Tests for general properties of Aggregates. Methods for Sampling)
Check on organic impurities	As directed by the Engineer

In addition to the above routine tests, the Contractor shall carry out the following tests at the frequencies stated:

(i) Moisture content; as frequently as may be required in order to control the water content of the concrete as required by the Specification.

(ii) Chloride content: as frequently as may be required to ensure that the proportion of chlorides in the aggregates does not exceed the limit stated in the Specification.

The Contractor shall take account of the fact that when the chloride content is variable it may be necessary to test every load in order to prevent excessive amounts of the chloride contaminating the concrete. For this purpose the Contractor shall use the rapid field test (Quantab test). In the event of disagreement regarding the results of the field test, the chloride content of the aggregate shall be determined in the laboratory as described in BS 812 (Volhard test).

5.3.6. 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 the contamination of 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.

5.3.7. Water for concrete and mortar

Seawater or brackish water containing more than 1000 ppm chloride ion or 2000 ppm sulphate ion shall not be used for mixing or curing concrete.

Water shall be clean and free from harmful matter and comply with the requirements of BS 3149.

The Contractor shall carry out tests in accordance with BS 3148 to establish compliance with the Specification.

5.3.8. Admixtures

(i) General

The use of the admixtures in concrete may be required under the Contract to promote special properties in the finished concrete or may be proposed by the Contractor to assist him in compliance with the Specification.

In all cases the Contractor shall submit to the Engineer full details of the admixture he proposes to use and the manner in which he proposes to add it to the mix. The information provided shall include:-

- a. The typical dosage, the method of dosing and the detrimental effects of an excess or deficiency in the dosage.
- b. The chemical names of the main active ingredients in the admixture.
- c. Whether or not the admixture contains chlorides, and if so the chloride ion content expressed as a Percentage by weight of admixture.
- d. Whether the admixture leads to the entrainment of air when used at the manufacturer's recommended dosage and if so, the extent to which it does so.
- e. Details of previous uses of the admixture in Kenya.

The chloride ion content of any admixture shall not exceed 2 per cent by weight of the admixture nor 0.03 per cent by weight of the cement in the mix.

Admixtures shall not be mixed together without the consent of the Engineer.

Calcium chloride or admixtures containing calcium chloride shall not be used in prestressed concrete.

(ii) Workability agents

Workability agents shall comply with BS 5075 and shall not have any adverse effect on the properties of the concrete.

5.4. The Design of Concrete Mixes

5.4.1. Classes of concrete

The classes of structural concrete to be used in the Works shall be those shown on the Drawings and designated in Table 5-1, in which the class designation includes two figures. The first figure is the nominal strength at 28 days expressed in N/mm² and the second figure is the maximum nominal size of aggregate in the mix expressed in millimeters.

TABLE 5-1 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 5.4.3(c)) N/mm ²	Early works test cubes (clause 5.4.4(d))	
			A	B		Any one cube N/mm	Average of any group of 4 cubes N/mm
10/75	10	75	0.60	0.55	13.5	9.5	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	0.57	0.48	31.5	17.0	27.5
20/20	20	20	0.55	0.48	31.5	17.0	27.5
20/10	20	10	0.53	0.48	31.5	17.0	27.5
25/40	25	40	0.50	0.46	36.5	21.3	32.5
25/20	25	20	0.52	0.46	36.5	21.3	32.5
25/10	25	10	0.50	0.46	36.5	21.3	32.5
30/40	30	40	0.48	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

NOTE: Under water/cement ratio, column A applies to moderate and intermediate exposure, and column B applies to severe exposure. See NOTE after Table 5-2.

5.4.2. Design of proposed mixes

The contractor shall design all the concrete mixes called for on the Drawings, making use of the ingredients which have been approved by the Engineer for use in the works and in compliance with the following requirements:-

(i) The aggregate portion shall be well graded from the nominal maximum size of stone down to the 150 micron size.

(ii) The cement content shall be such as to achieve the strengths called for in Table 5-1 but in any case not less than the minimum necessary for impermeability and durability shown in Table 5-2.

(iii) The workability shall be consistent with ease of placing and proper compaction having regard to the presence of reinforcement and other obstructions.

(iv) The water/cement ratio shall be the minimum consistent with adequate workability but in any case not greater than that shown in Table 5-1 taking due account of any water contained in the aggregates. The Contractor shall take into account that this requirement may in certain cases require the inclusion of a workability agent in the mix.

(v) The drying shrinkage determined in accordance with BS 1881 shall not be greater than 0.05 per cent.

Table 5-2 Minimum Cement Content

Class of Concrete	Minimum Cement Content - Kg/ m ³ of Compacted concrete		
	Moderate Exposure	Intermediate Exposure	Severe Exposure
10/75; 15/75	200	220	270
15/40, 20/40, 25/40, 30/40	240	270	290
15/20, 20/20, 25/20, 30/20	260	300	330
40/20	300	320	330
20/10, 25/10, 30/10	300	340	390
40/10	310	340	390

NOTE: the minimum cement contents shown in the above table are required in order to achieve impermeability and durability. In order to meet the strength requirements in the Specification higher contents may be required.

The categories applicable to the Works are based broadly on the factors listed hereunder:

Moderate exposure Surface sheltered from severe rain; buried concrete, concrete continuously under water

Intermediate Surface exposed to driving rain; alternate exposure wetting and drying; traffic; corrosive fumes; heavy condensation.

Severe exposure Surface exposed to sea water, moorland water having a pH of 4.5 or less, Groundwater containing sulphates.

5.4.3. Trial mixes

At least six weeks before commencing placement of concrete in the Permanent works trial mixes shall be prepared for each class of concrete specified-

For each mix of concrete for which the Contractor has proposed a design, he shall prepare three separate batches of concrete using the materials which have been approved for use in the Works and the mixing plant which he proposes to use for the works. The volume of each batch shall be the capacity of the concrete mixer proposed for full production.

Samples shall be taken from each batch and the following action taken, all in accordance with BS 1881:-

- (i) The slump of the concrete shall be determined.
- (ii) Six test cubes shall be cast from each batch. In the case of concrete having a maximum aggregate size of 40 mm or less, 150 mm cubes shall be used. In the case of concrete containing 75 mm or larger aggregate, 200mm cubes shall be used and in addition any pieces of aggregate retained on a 53 mm BS sieve shall be removed from the mixed concrete before casting the cubes.
- (iii) Three cubes from each batch shall be tested for compressive strength at seven days and the remaining three at 28 days.
- (iv) The density of all the cubes shall be determined before the strength tests are carried out.

Subject to the agreement of the Engineer, the compacting factor apparatus may be used in place of a slump cone. In this case the correlation between slump and

compacting factor shall be established during preparation of the trial mixes.

The average strength of the nine cubes tested at 28 days shall be not less than the target mean strength shown in Table 5-1.

The Contractor shall also carry out tests to determine the drying shrinkage of the concrete unless otherwise directed by the Engineer.

Based on the results of the tests on the trial mixes, the Contractor shall submit full details of his proposals for mix design to the Engineer, including the type and source of each ingredient, the proposed proportions of each mix and the results of the tests on the trial mixes.

If the Engineer does not agree to a proposed concrete mix for any reason, the Contractor shall amend his proposals and carry out further trial mixes. No mix shall be used in the works without the written consent of the Engineer.

5.4.4. Quality control of concrete production

(i) Sampling

For each class of concrete in production at each plant for use in the works, samples of concrete shall be taken at the point of mixing and/or of deposition as instructed by the Engineer, all in accordance with the sampling procedures described in BS 1881 and with the further requirements set out below.

Six 150 mm or 200 mm cubes as appropriate shall be made from each sample and shall be cured and tested all in accordance with BS 1881-125:2013 (Testing Concrete. Methods for mixing and sampling fresh concrete in the laboratory), two at seven days and the other four at 28 days.

Each sample shall be taken from one batch selected at random and at intervals such that each sample represents not more than 20 m³ of concrete unless the Engineer agrees to sampling at less frequent intervals.

Until compliance with the Specification has been established the frequency of sampling shall be three times that stated above or such lower frequency as may be instructed by the Engineer.

(ii) Testing

a) The slump or compacting factor of the concrete shall be determined for each batch from which samples are taken and in addition for other batches at the frequency instructed by the Engineer.

The slump of the concrete in any batch shall not differ from the value established by the trial mixes by more than 25 mm or one third of the value, whichever is the greater.

The variation in value of the compacting factor, if used in place of a slump value, shall be within the following limits:

For value of 0.9 or more	±0.03
For value of between 0.8 and 0.9	±0.04
For values of 0.8 or less	±0.05

b) The water/cement ratio as estimated from the results of (a) above, determined by samples from any batch shall not vary by more than five per cent from the value established during the trial mixes.

c) The air content of air entrained concrete in any batch shall be within 1.5 units of the required value and the average value of four consecutive measurements shall be within 1.0 unit of the required value, expressed as a percentage of the volume of freshly mixed concrete.

d) Until such time as sufficient test results are available to apply the method of control described in (e) below, the compressive strength of the concrete at 28 days shall be such that no single result is less than the value shown in Table 5-1 under the heading 'early works test cubes' and also that the average value of any four consecutive results is not less than the value shown in Table 5-1 under the same heading.

The 7-day cube result may be used as an early strength indicator, at the discretion of the Engineer.

e) When test cube results are available for at least 20 consecutive batches of any class of concrete mixed in any one plant, the average of any four

consecutive results at 28 days shall exceed the nominal strength by not less than half the current margin (see table below) and each individual result shall not be less than 85 per cent of the nominal strength.

The current margin shall be defined as 1.64 times the standard deviation of cube tests on at least 20 separate consecutive batches produced from one plant over a period exceeding five days but not exceeding six months or on at least 50 separate consecutive batches produced from one plant over a period not exceeding 12 months. If both figures are available, the smaller shall be taken.

The current margin shall in any case be less than the figure given below:-

	Minimum current margin for		
	10N/m ²	15N/mm ²	20N/mm ² and above
After 20 batches	3.3	5	7.5
After 50 batches	1.7	2.5	3.8

f) Failure to comply with requirements

If any one test cube result in a group of four consecutive results is less than 85 per cent of the nominal strength but the average of the group of which it is part satisfies the strength requirement, then only the batch from which the failed cube was taken shall be deemed not to comply with the Specification.

If more than one cube result in a group of four consecutive results is less than 85 per cent of the nominal strength or if the average strength of the group of which it is part fails to satisfy the strength requirement then all the batches between those represented by the first and last cubes in the group shall be deemed not to comply with the Specification, and the Contractor shall immediately adjust the mix design subject to the agreement of the Engineer to restore compliance with the Specification.

After adjustment of the mix design the Contractor will again be required to comply with sub- (clauses 5.4 (b) and 5.4 (c) of this Section of this Specification.

The Contractor shall take necessary action to remedy concrete which does not comply with this Specification. Such action may include but is not necessarily confined to the following:-

- (i) Increasing the frequency of sampling until control is again established.
- (ii) Cutting test cores from the concrete and testing in accordance with BS 12504-1:2000 (Testing Concrete Structures. Cored Specimens. Taking, examining and testing in compression).
- (iii) Carrying out strengthening or other remedial work to the concrete where possible or appropriate.
- (iv) Carrying out non destructive testing such as load tests on beams
- (v) Removing the concrete

5.4.5. Mixing Concrete

Before any plant for batching, mixing, transporting, placing, compacting and finishing concrete is ordered or delivered to site, the Contractor shall submit to the Engineer full details including drawings of all the plant which he proposes to use and arrangements he proposes to make.

Concrete for the works shall be batched and mixed in one or more central plants unless the Engineer agrees to some other arrangement. If the Contractor proposes to use ready mixed concrete he shall submit to the Engineer for his approval full details and test results of the concrete mixes. The Engineer may approve the use of ready mixed concrete provided that:

- a. The proposed mixes, the material to be used and the method of storage and mixing comply with the requirements of the specification; and
- b. Adequate control is exercised during mixing.

Approval to the use of ready mixed concrete may be withdrawn if the Engineer is not satisfied with the control of the materials being used and control during mixing.

Batching and mixing plants shall be modern efficient equipment complying with the requirements of BS 1305 and capable of producing a uniform distribution of the ingredients throughout the mass. Truck mixes shall comply with the requirements of BS 4251-1974 and shall only be used with prior arrangement with the engineer. If the plant proposed by the contractor does not fall within the scope of BS1305, it shall have been tested in accordance with BS 3963 and shall have a mixing performance within the limits of Table 6 of BS 1305.

All mixing operations shall be under the control of an experienced supervisor.

The aggregate storage bins shall be provided with drainage facilities arranged so that drainagewater is not discharged to the weigh hoppers. Each bin shall be drawn down at least once per week and any accumulations of mud or silt removed.

Cement and aggregates shall be batched by weight. Water may be measured by weight or volume.

The weighing and water dispensing mechanisms shall be maintained in good order. Their accuracy shall be maintained within the tolerances described in BS 1305 and checked against accurate weights and volumes when required by the Engineer.

The weights of cement and of each size of aggregate as indicated by the mechanisms employed shall be within a tolerance of plus or minus two per cent of the respective weight per batch agreed by the Engineer.

The Contractor shall provide standard test weights at least equivalent to the maximum working load used on the most heavily loaded scale and other auxiliary equipment required for checking the satisfactory operation of each scale or other measuring device. Tests shall be made by the Contractor at least once a week or at intervals to be determined by the Engineer and shall be carried out in his presence. For the purpose of carrying out these tests, there shall be easy access for personnel to the weigh hoppers. The Contractor shall furnish the Engineer with copies of the complete results of all check tests and shall make any adjustments, repairs or replacements necessary to ensure satisfactory performance.

The nominal drum or pan capacity of the mixer shall not be exceeded. The turning speed and the mixing time shall be as recommended by the manufacturer, but in addition, when water is the last ingredient to be added, mixing shall continue for at least one minute after all the water has been added to the drum or pan.

The blades of pan mixers shall be maintained within the tolerances specified by the manufacturer of the mixer and the blades shall be replaced when it is no longer possible to maintain the tolerances by adjustment.

Mixers shall be fitted with an automatic recorder registering the number of batches discharged.

The water to be added to the mix shall be reduced by the amount of free water contained in the coarse and fine aggregates. This amount shall be determined by the Contractor by a method agreed by the Engineer immediately before mixing begins each day and thereafter at least once per hour during concreting and for each delivery of aggregates during concreting. When the correct quantity of water, determined as set out in the Specification, has been added to the mix, no further water shall be added, either during mixing or subsequently.

After mixing for the required time, each batch shall be discharged completely from the mixer before any materials for the succeeding batch are introduced.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed and thereafter the first batch of concrete through the mixers shall contain only half the normal quantity of coarse aggregate. This batch shall be mixed for one minute longer than the time applicable to a normal batch.

Mixers shall be cleaned out before changing to another type of cement.

5.4.6. 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 metres 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.

5.4.7. Transport of Concrete

The concrete shall be discharged from the mixer and 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 at the point and time of placing. The loss of slump between discharge from the mixer and placing shall not exceed 25 mm.

The time elapsing between mixing and placing a batch of concrete shall be as short as practicable as 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.

5.5. Placing of Concrete

5.5.1. 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 days 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.

5.5.2. Preparation of surface to receive concrete

Excavated surfaces on which concrete is to be deposited shall be prepared as set out in Section 4 of this Specification.

Existing concrete surfaces shall be prepared as set out in (clause 5.19. 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 or 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 be not less than 5 mm thick.

If any fissures have been cleaned out as described in Section 4 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.

5.5.3. 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 500 mm 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 not be placed so that they 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 as 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 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 accumulations of water.

In dry 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.

Forms for walls, columns and other than sections of significant height shall be provided with openings or other devices that will permit the concrete to be placed in a manner that will prevent segregation and accumulations of hardened concrete on the formwork or reinforcement above the level of the placed concrete.

When it is necessary to place concrete under water the contractor shall submit to the Engineer his proposals for the method and equipment to be employed. The concrete shall be deposited either by bottom-discharging watertight containers or through funnel-shaped tremies which are kept continuously full with concrete up to a level above the water and which shall have the discharging bottom fitted with a trapdoor and immersed in the concrete in order to reduce to a minimum the contact of the concrete with the water. Special care shall be taken to avoid segregation.

If the level of concrete in a tremie pipe is allowed to fall to such an extent that water enters the pipe, the latter shall be removed from the pour and filled with concrete before being again lowered into the placing position.

During and after concreting under water, pumping or de-watering in the immediate vicinity shall be suspended if there is any danger that such work will disturb the freshly placed concrete.

5.5.4. 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

5.09. 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 resumption, the new concrete shall be thoroughly worked in and compacted against the existing concrete so as to eliminate any cold joints.

5.5.5. 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 5.8 (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.

5.5.6. 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.

5.6. 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 rises 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 another method.

Immersion vibrators shall operate at the frequency of between 7,000 and 10,000 cycles per minute. The contractor shall ensure that vibrators are operated at beginning 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 the entire quantity of concrete being placed to be vibrated for the necessary period and, in addition stand-by 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 100 mm 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 which shall not exceed the distance from the vibrator over which vibration is visibly effective.

5.7. 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 of 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-(clauses 5.11 (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.

(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 300 mm.

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 5.11 (c).

Water used for curing shall be of the same quality as that used for mixing as stated in sub- (clause 5.4 (g).

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 per cent. Curing compounds shall contain a fugitive dye to enable the extent of the spread to be seen easily.

Curing compound used on surfaces exposed to the sky shall contain sufficient finely divided flake aluminum 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 and shall not crack, peel or disintegrate within three weeks after application.

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.

(c) Limitation of temperature differentials

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 5.13(b);
- (ii) Use of low heat cement, subject to the agreement of the Engineer;
- (iii) Insulation of exposed concrete surfaces by insulating blankets. Such blankets shall have an insulation value at least equivalent to 50 mm 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.

5.8. 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 5.4.

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.

5.9. Concreting in Hot Weather

5.9.1. 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.

5.9.2. 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°C and that the concrete does not lose 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.

5.10. Finishes on Unformed Surfaces

Horizontal or nearly horizontal surfaces which are not cast against formwork shall be finished to the class shown on the Drawings and defined hereunder.

5.10.1. UF 1 finish

All surfaces on which no higher class of finish is called for on the Drawings or instructed by the Engineer shall be given an UF 1 finish.

The concrete shall be leveled and screeded to produce a uniform plain or ridged surface, surplus concrete being struck off by a straight edge immediately after compaction.

5.10.2. UF 2 finish

This is a floated finish for roof or floor slabs and other surfaces where a hard trowelled surface is not required.

The surface shall first be treated as a Class UF 1 finish and after the concrete has hardened sufficiently, it shall be floated by hand or machine sufficient only to produce a uniform surface free from screed marks.

5.10.3. UF 3 finish

This is a hard trowelled surface for use where weather resistance or appearance is important, or which is subject to high velocity water flow.

The surface shall be floated as for a UF 2 finish but to the tolerance stated below. When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, it shall be steel-trowelled under firm pressure to produce a dense, smooth uniform surface free from trowel marks.

Table 5-3 Surface Tolerances

Class of Finish	Tolerance in mm. see notes		
	A	B	C
UF 1	Not applicable	10	+ 20 or - 10
UF 2	Nil	10	+ 20 or - 10
UF 3	Nil	5	+ 12.5 or -7.5

Notes:

1. Col A is the maximum allowable value of any sudden change of level in the surface.
2. Col B is the maximum allowable value of any gradual irregularity of the surface, as indicated by the gap between the surface and a three metre long straight edge or correctly shaped template placed on the surface.
3. Col C is the maximum allowable value of the difference in level or position between a threemetre long straight edge or correctly shaped template placed on the surface and the specified level or position of that surface.
4. Where dimensional tolerances given on the Drawings or in this Special Specification they shall take precedence over those given in Table 5-3.

5.11. 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 5.3 (c) and Ordinary Portland Cement complying with KS02-21. 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 twoparts of fine aggregate by weight.

Small quantities of mortar may be hand mixed but for amounts over 0.5 m a mechanical mixershall 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.

5.12. Concrete for Secondary Purposes

a) **Non-structural concrete (NS concrete)** shall be used only for non-structural purposes where shown on the drawings.

NS concrete shall be composed of Ordinary Portland Cement complying with KS02-21 and aggregates complying with BS 932-1: 1997 including all-in aggregate within the grading limits of Table 3 of BS 932-1: 1997.

The weight of cement mixed with 0.3 m metres of combined or all-in aggregate shall not be less than 50 kg. The mix shall be proportioned by weight or by volume. The maximum aggregate size shall be 40 mm nominal.

The concrete shall be mixed by machine or by hand to a uniform colour and consistency before placing. The quantity of water used shall not exceed that required to produce a concrete with sufficient workability to be placed and compacted where required.

The concrete shall be compacted by hand or by mechanical vibration.

b) **No Fines concrete (NF concrete)** is intended for use where a porous concrete is required and shall only be used where shown on the Drawings or instructed by the Engineer.

The mix shall consist of Ordinary Portland Cement complying with KS02-21 and aggregate complying with BS 882. The aggregate size shall be 40.0 mm to 10.0 mm only. The weight of cement mixed with 0.3 m³ metre of aggregate shall not be less than 50 kg. The quantity of water shall not exceed that required to produce a smooth cement paste which will coat evenly the whole of the aggregate.

5.13. Records of Concrete Placing

Records, in a form agreed by the Engineer, shall be kept by the Contractor of the details of every pour of concrete placed in the works. These records shall include class of concrete, location of pour, date of pour, ambient temperature and concrete temperature at time of placing, moisture contents of aggregates, details of mixes, batch numbers, cement batch number, results of all tests undertaken, location of test cube sample points and details of any cores taken.

The Contractor shall supply to the Engineer four copies of these records each week covering work carried out the preceding week. In addition he shall supply to the Engineer monthly histograms of all 28 day cube strengths together with accumulative and monthly standard deviations and any other information which the Engineer may require concerning the concrete placed in the works.

5.14. Construction Joints

Whenever concrete is to be bonded to other concrete which has hardened, the surface of contact between the sections shall be deemed a construction joint.

Where construction joints are shown on the Drawings, the Contractor shall form such joints in those positions. The location of joints which the Contractor requires to make for the purpose of construction shall be subject to the agreement of the Engineer. Construction joints shall be in vertical or horizontal planes except in sloping slabs where they shall be normal to the exposed surface or elsewhere where the Drawings require a different arrangement.

Construction joints shall be so arranged as to reduce to a minimum the effects of shrinkage in the concrete after placing, and shall be placed in the most advantageous positions with regard to stresses in the structures and the desirability of staggering joints.

Feather edges of concrete at joints shall be avoided and any feather edges which may have formed where reinforcing bars project through a joint shall be cut back until sound concrete has been reached.

The intersections of horizontal or near horizontal joints and exposed faces of concrete shall appear as straight lines produced by use of a guide strip fixed to the formwork at the top of the concrete lift, or by other means acceptable to the Engineer.

Construction joints formed as free surfaces shall not exceed a slope of 20 per cent from the horizontal.

The surface of the fresh concrete in horizontal or near horizontal joints shall be thoroughly cleaned and roughened by means of high pressure water and air jets when the concrete is hard enough to withstand the treatment without the leaching of cement. The surface of vertical or near vertical joints shall be similarly treated if circumstances permit the removal of formwork at a suitable time.

Where concrete has become too hard for the above treatment to be successful, the surface whether formed or free is to be thoroughly scabbled by mechanical means or wet sand blasted and then washed with clean water. The indentations produced by scabbling shall be not less than 10 mm deep and shall not extend closer than 40 mm to a finished face.

If instructed by the Engineer the surface of the concrete shall be thoroughly brushed with a thin layer of mortar composed of one part of cement to two parts of sand by weight and complying with Clause 5.4 all as set out in Sub-Clause 5.9.2 (b) immediately prior to the deposition of fresh concrete. The mortar shall be kept just ahead of the fresh concrete being placed and the fresh layer of concrete shall be thoroughly and systematically vibrated to full depth to ensure complete bond with the adjacent layer.

No mortar or concrete may be placed in position on or against a construction joint until the joint has been inspected and passed by the Engineer.

5.15. Expansion and Contraction Joints

Expansion and contraction joints are discontinuities in concrete designed to allow for thermal or other movements in the concrete.

Expansion joints are formed with a gap between the concrete faces to permit subsequent expansion of the concrete. Contraction joints are formed to permit initial contraction of the concrete and may include provision for subsequent filling.

Expansion and contraction joints shall be formed in the positions and in accordance with the details shown on the Drawings or elsewhere in the Specifications.

5.16. Waterstops

All references to waterstops include grout stops.

Waterstops shall be of the material and form shown on the Drawings. No water-stop material shall be brought onto site until the Contractor has submitted full details of the materials he proposes to use, including samples, and these have been approved by the Engineer. All samples shall be of adequate length for testing.

Waterstops shall be made of material which are resistant to chlorides, sulphates, or other deleterious substances which may be present in the environment of the Works.

Rubber waterstops may be of natural or synthetic rubber and shall have an elongation at breaking stress of at least 500 per cent at 25°C and shall allow a joint movement of at least 50mm.

Polyvinyl chloride (PVC) waterstops shall be extruded from unfilled plasticised PVC polymer or copolymer which does not contain any reclaimed or scrap PVC. PVC waterstops shall have an elongation at breaking stress of at least 225 per cent at 25°C and shall allow a joint movement of at least 10 mm.

Low modulus waterstops shall be of rubber or PVC as described above but shall have an elongation of at least 200 per cent at 25°C under a tensile stress of 6 N/mm² and shall allow a joint movement of at least 50 mm.

Waterstops shall be supplied in lengths as long as possible consistent with ease of handling and construction requirements.

In rubber or plastic materials joints other than butt joints shall be supplied ready made by the manufacturer. Butt joints shall be made on site in accordance with the manufacturer's instructions and with equipment supplied for the purpose by the manufacturer.

Waterstop material shall be stored carefully on Site to avoid damage and contamination with oil, grease, or other pollutants. Rubber and plastic waterstops shall be stored in cool well ventilated places away from direct sunlight.

Rubber and plastic waterstops which are embedded in one side of a joint more than one month before the scheduled date of placing concrete on the other side shall be protected from the sun.

Waterstops shall be firmly fixed in the formwork so that they cannot be displaced during concrete placing and shall be completely free of all dirt, grease, oil, etc before placing concrete. Where eyelets are provided these shall be fully wired to the reinforcement and be the only means whereby the waterstop is fixed. In no circumstances shall a waterstop be punctured with nails etc as a means of fixing.

Concrete shall be placed carefully round waterstops so as to avoid distortion or displacement and shall be fully compacted. Where waterstops lie in a horizontal or nearly horizontal plane the Contractor shall ensure that no voids are left on the underside of the waterstop.

Formwork round waterstops shall be carefully removed to avoid damage. If waterstops suffer any damage which cannot be properly repaired in situ the Engineer may require a section of concrete to be removed and the waterstop replaced.

5.17. Grouting of Pockets and Holes and Underpinning of Baseplates

Pockets and holding-down boltholes shall be thoroughly cleaned out using compressed air and water jet. Holes drilled by a diamond bit shall be roughened. The pockets and holes shall be filled with grout consisting of cement and clean fresh water mixed in proportion of two parts by weight of cement to one part by weight of water. The pouring of liquid grout shall cease as soon as each hole is filled

and any excess grout on the surface of the concrete foundation shall be completely removed and the surface dried off before the next operation proceeds.

The space between the top surface of foundation concrete and the underside of base plates shall be filled with a special mortar made up in the following proportions :-

Portland cement....50 kg

Fine aggregate 50 kg

An additive acceptable to the Engineer to counteract shrinkage in proportions recommended by the manufacturer.

The special mortar shall be mixed with -the lowest water-cement ratio which will result in a consistency of mix of sufficient workability to enable maximum compaction to be achieved.

The special mortar shall then be well rammed in horizontally below the baseplate and from one edge only until it is extruded from the other three sides. The mortar which has extruded shall then be rammed back to ensure complete support without voids.

5.18. 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.

Falsework means the structural elements supporting both the framework 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.

5.19. Construction of Formwork and Falsework

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

Formwork and falsework 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 5.26.

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 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° to the horizontal or steeper. Surfaces at slopes less than 20° may be formed by screeding. Surfaces at slopes between 20° and 30° 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 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 50 mm to the face of the Concrete.

Formwork shall not be re-used after it has suffered damage which 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 5.26 and fixed so that they cannot move when concrete is placed against them.

5.20. 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 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, discoloration of the concrete, air holes on the concrete surface, or retards the rest of the concrete, in order to avoid colour differences on adjacent concrete surfaces, only one type or 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.

5.21. 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 5-4 and apply to ambient temperatures higher than 10°C at lower temperatures or if cement other than ordinary Portland are involved, the Engineer may instruct longer periods.

Alternatively, formwork may be removed when the concrete has attained the strength set out in Table 5-4, 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 this requirement 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 5-4 Minimum Periods for Formwork Removal

Position of Formwork	Minimum Period for Temps over 10°C	Strength to be Attained
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Vertical or near vertical faces of mass concrete	24 hours	0.2 C
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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 under-ground works	24 hours	4N/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 (or 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.

5.22. Surface Finishes

Classes of finish

The surface finish to be achieved on formed concrete surfaces shall be as shown on the Drawings and defined hereunder:-

5.22.1.(a) Class F1 finish

This finish is for surfaces against which backfill or further concrete will be placed. Formwork may be sawn boards, sheet metal or any other suitable material which will prevent the loss of fine material from the concrete being placed.

5.22.2.(b) Class F2 finish

This finish is for surfaces which are permanently exposed to view but where the highest standard of finish is not required. Forms to provide a Class F2 finish shall be faced with wrought thicknesses tongued and grooved boards with square edges arranged in a uniform pattern and close jointed or with suitable sheet material. The thickness of boards or sheets shall be such that there shall be no visible deflection under the pressure exerted by the concrete placed against them. Joints between boards or panels shall be horizontal and vertical unless otherwise directed. This finish shall be such as to require no general filling of surface pitting, but fins, surface discolouration and other minor. Defects shall be remedied by methods agreed by the Engineer.

5.22.3.(c) Class F3 finish

This finish is for surfaces which will be in contact with water flowing at high velocity, and for surfaces prominently exposed to view where good appearance is of special importance. To achieve this finish, which shall be free of board marks, the formwork shall be faced with plywood complying with BS 1088 or equivalent material in large sheets. The sheets shall be arranged in an approved uniform pattern. Wherever possible, joints between sheets shall be arranged to coincide with architectural features or changes in direction of the surface.

All joints between panels shall be vertical and horizontal unless otherwise directed. Suitable joints shall be provided between sheets to maintain accurate alignment in the plane of the sheets. Unfaced wrought boarding or standard steel panels will not be permitted for Class F3 finish. The Contractor shall ensure that the surface is protected from rust marks, spillages and stains of all kinds.

5.22.4.(d) Curved surfaces

For curved surfaces where F2 or F3 finishes are called for, the formwork face shall be built up of splines cut to make a tight surface which shall then be dressed to produce the required finish.

Alternatively single curvature surfaces may be faced with plastic or plywood linings attached to the backing with adhesive or with escutcheon pins driven flush. Linings shall not bulge, wrinkle or otherwise deform when subjected to temperature and moisture changes.

5.23. Tolerances

All parts of formed concrete surfaces shall be in the positions shown on the Drawings within the tolerances set out in Table 5-5.

In cases where the Drawings call for tolerances other than those given in Table 5-5 the Drawings shall rule.

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 5-5 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:

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

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

C is the amount by which the whole or part of a concrete face is displaced for the correct position shown on the Drawings.

5.24. 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 honeycombing which the Engineer agrees may be repaired shall be cut back to sound concrete or to 75 mm whichever is the greater distance. In the case of reinforced concrete the area shall be cut back to at least 25 mm clear distance behind the reinforcement or to 75 mm, 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 surfaces 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 20 mm 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 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 5.26 shall be ground and in the manner and to the extent instructed by the Engineer.

Defects other than those mentioned above shall be dealt with as instructed by the Engineer.'

5.25. Reinforcement for Concrete

Reinforcement which shall comply with the following British Standards, covers plain and deformed bar reinforcement and steel fabric to be cast into concrete in

any part of the works but does not include prestressing tendons or any other embedded steel.

- BS 4449 for hot rolled plain bar and high yield deformed bar
- BS 4482 for hard drawn mild steel wire
- BS 4461 for cold worked steel bar
- BS 4483 for steel mesh fabric

All reinforcement shall be from an approved manufacturer and, if required by the Engineer, the Contractor shall submit a test certificate from the manufacturer.

All reinforcement for use in the Works shall be treated for compliance with the appropriate British Standard in a laboratory acceptable to the Engineer and two copies of each test certificate shall be supplied to the Engineer. The frequency of testing shall be as set out in the British Standard.

In addition to the testing requirements described above, the Contractor shall carry out additional tests as instructed by the Engineer.

Any reinforcement which does not comply with the Specification shall be removed from Site.

5.26. Storage of Reinforcement

All reinforcement shall be delivered to Site either in straight lengths or cut and bent. No reinforcement shall be accepted in long lengths which have been transport bent over double.

Any reinforcement which is likely to remain in storage for a long period shall be protected from the weather so as to avoid corrosion and pitting. All reinforcement which has become corroded or pitted to an extent which, in the opinion of the Engineer, will affect its properties shall either be removed from Site or may be tested for compliance with the appropriate British Standard in accordance with Clause 5.28 of this Specification at the Contractor's expense.

5.27. Bending Reinforcement

Unless otherwise shown on the drawings, bending and cutting shall comply with BS 4466.

The Contractor shall satisfy himself as to the accuracy of any bar bending schedules supplied and shall be responsible for cutting, bending, and fixing the reinforcement in accordance with the Drawings.

Bars shall be bent cold by the application of slow steady pressure. At temperatures below 5°C the rate of bending shall be reduced if necessary to prevent fracture of the steel.

After bending, bars shall be securely tied together in bundles or groups and legibly labelled as set out in BS 4466.

Reinforcement shall be thoroughly cleaned and all dirt, scale, loose rust, oil and other contaminants removed before it is placed in the Works.

5.28. Fixing Reinforcement

Reinforcement shall be securely fixed in position within a dimensional tolerance of 20 mm in any direction parallel to a concrete face and within a tolerance of 5 mm at right angles to a face, provided that the cover is not thereby decreased below the minimum 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 whichever is the greater.

Unless otherwise agreed by the engineer, all intersecting bars shall either be tied together with

1.6 mm diameter soft annealed iron wire and the ends of the wire turned into the body of the concrete, or shall be secured with a wire clip of a type agreed by the Engineer.

Spacer blocks shall be used for ensuring that the correct cover is maintained on the reinforcement. Blocks shall be as small as practicable and of a shape agreed by the Engineer. They shall be made of mortar mixed in the proportions of one part of cement to two parts of sand. Wires cast into the block for tying in to the reinforcement shall be 1.6 mm diameter soft annealed iron.

Alternatively another type of spacer block may be used subject to the Engineer's agreement.

Reinforcement shall be rigidly fixed so that no movement can occur during concrete placing. Any fixings made to the formwork shall not be within the space to be occupied by the concrete being currently placed.

No splices shall be made in the reinforcement except where shown on the Drawings or agreed by the Engineer. Splice lengths shall be as shown on the Drawings.

Reinforcement shall not be welded except where required by the Contract or agreed by the Engineer. If welding is employed, the procedures shall be as set out in BS 2640 for gas welding or BS EN 1011-2:2001 (Welding. Recommendations for welding of metallic materials. Arc Welding of ferritic Steels) for metal arc welding. Full strength butt welds shall only be used for steel complying with BS 4449:2005 + A3:2016 (Steel for reinforcement of Concrete. Weldable reinforcing steel bar coil and decoiled product), and if used on high yield deformed bars complying with BS 4449:2005 the permissible stresses in the vicinity of the weld shall be reduced to those applicable to plain bars complying with that specification.

Mechanical splices shall not be used unless the Engineer agrees otherwise.

The Contractor shall ensure that reinforcement left exposed in the Works shall not suffer distortion, displacement or other damage. When it is necessary to bend protruding reinforcement aside temporarily, the radius of the bend shall not be less than four times the bar diameter for mild steel bars or six times the bar diameter for high yield bars. Such bends shall be carefully straightened before concrete placing continues, without leaving residual kinks or damaging the concrete round them. In no circumstances will heating and bending of high yield bars be permitted.

Bars complying with BS 4449:2005 or other high tensile bars shall not be bent after placing in the Works.

Before concrete is placed in any section of the Works that includes reinforcement, the reinforcement shall be completely clean and free from all contamination including concrete, which may have been deposited on it from previous operations.

5.29. Precast Concrete

Precast concrete covers all precast units for use in the Works, whether instructed under the Contract or proposed by the Contractor, and includes prestressed units where applicable. Additional requirements for prestressed units are set out in Section 18 of this Specification.

5.30. Moulds for Precast Units

Moulds for precast units shall comply with the general requirements of Clauses 5.21 to 5.29.

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 de-moulding shall not stain the concrete or affect its properties in anyway.

5.31. Reinforcement for Precast Units

Reinforcement in precast units shall comply with the requirement of Clauses 5.28 to 5.31. When preformed cages are used, the cages shall be made up on jigs to ensure dimensional accuracy and shall be carefully supported within the mould in such a way that they cannot move when concrete is placed. Reinforcement complying with BS 4449:2005 may be tack welded where bars cross to provide rigidity in the cage.

Cover to main reinforcement shall be as shown on the Drawings, or if not shown shall be not less than 25 mm or the diameter of the bar, whichever is the greater.

Cover on distribution steel shall not be less than 15 mm 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 millimeters 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.

5.32. Casting of Units

Concrete for precast units shall comply with Clauses 5.03 to 5.09 using the class of concrete specified on the Drawings.

If lightweight aggregates are specified, they shall comply with BS EN 13055-1:2002 (Lightweight Aggregates. Lightweight aggregates for concrete, mortar and grout)

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

5.33. Curing Precast Units

Requirements for curing shall be generally as set out in Clause 5.10. 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°C of the temperature of the unit being cured.

If the Contractor proposes curing at elevated temperature, 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.

5.34. Dimensional Tolerances of Precast Units

Units shall be accurately formed to the dimensions shown on the Drawings and within the tolerances set out in EN1992 unless closer tolerances are called for in the Special Specification or on the Drawings

5.35. Surface Finish of Precast Units

The formed faces of precast units shall be finished to Class F3 as set out in Clause 5.25 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 the use of a needle gun.

5.36. Handling and Storage of Precast Units

Precast units shall be handled in a manner which will not cause any kind damage 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.

5.37. Testing Precast Units

Precast units shall be capable of safely sustaining the load 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 fails, the batch of units which they represent may be rejected.

5.38. Measurement and payment

5.38.1. Item: Concrete

Unit: m³ of each class

Concrete shall be measured by the cubic metre of each class calculated from the dimensions given on the Drawings or instructed by the Engineer. No deduction shall be made in the measurement for:

- (i) bolt holes, pockets, box outs and cast in components provided that the volume of each is less than 0.15 cubic metres;
- (ii) mortar beds, fillets, drips, rebates, recesses, grooves, chamfers and the like of 100 mm total width or less;
- (iii) reinforcement

The rate for concrete shall include for the cost of:-

- (i) Provision and transport of cement aggregates and water.
- (ii) Admixtures and workability agents including submission of details unless specified.
- (iii) Hatching, mixing, transporting, placing, compacting and curing.
- (iv) Class UF1 finish.
- (v) Laying to sloping outfaces not exceeding 15° from the horizontal and to falls.
- (vi) Formwork to blinding concrete.
- (vii) Placing and compacting against excavated surfaces where required including any additional concrete to fill overbreak or working space.
- (viii) Complying with the requirements of Clauses 5.1 to 5.18 inclusive and Clause 5.27 of this Specification.

5.38.2. Item: Blinding concrete

Unit: m³

Blinding concrete shall be measured by the cubic metre calculated as the product of the plan area of the foundation as shown on the Drawings and the instructed thickness. No deduction shall be made for openings provided that the area of each is less than 0.5 square metres. Blinding concrete over hard material shall be measured as the volume used provided that the maximum thickness of 150 mm allowed for overbreak is not exceeded.

The rate for blinding concrete shall include for all costs itemized in Clause 5.41.1 (a) of this Specification.

5.38.3.Item: No fines concrete.

Unit: m³

No fines concrete shall be measured by the calculated cubic metre from the dimensions given on Drawings or instructed by the Engineer.

The rate for no fines concrete shall include: for all costs stated in Clause 5.41.1 (a) of this Specification.

5.38.4.Item: Unformed surface finishes

Unit m² of each class of finish

Unformed surface finishes shall be measured by the square metre from the dimensions given on the Drawings or instructed by the Engineer.

The rate for concrete in Clause 5.41.1 (a), 5.41.2 (b) and 5.41.3 (c) shall include for class UFI finish.

The rate for unformed surface finishes shall include for the cost of complying with Clause 5.13 of this Specification.

5.38.5.Item: Formed surface finishes

Unit: m² of formed Surface for each class of finish for each range of inclinations.

Except as stated below, formed surfaces shall be measured by the square metre of the finished face of the concrete. No deduction shall be made in the measurement for openings, pipes, ducts and the like, provided that the area of each is less than 0.50 square metres.

Formed Surfaces less than 300 mm high to edges of slabs shall be measured by the linear metre in accordance with Clause 5.41.6 (f) of this Specification.

Formed Surfaces required for blinding concrete, to form construction joints and shear keys for future concrete and other construction surfaces shall not be measured and the costs shall be included in the rates for other work.

Formed Surfaces to contraction and expansion joints shall be measured by the square metre on one face only. The rates shall include for the costs stated below and for forming recesses for sealant and channels for grout.

The rates for formed Surface shall include for the cost of submission of details providing and transporting all materials for formwork and falsework, erection including provision of supports, fillets and chamfers 75 mm and less in width, bolts, ties, fixings, cutting to waste, drilling or notching the formwork for reinforcement where required, working around pipes, ducts, conduits and waterstops, temporary openings, cleaning, dressing, stripping, filling bolt holes and any remedial work and for complying with Clauses 5.08, 5.10, 5.17, 5.18, 5.19 and 5.21 to 5.27 inclusive of this Specification.

The rate shall also include for costs of constructing formed surfaces to any inclination, shape or curvature as shown in the drawing or as instructed by the Engineer.

5.38.6.Item Formwork to edges of slabs

Unit: m of each class of finish

Formwork less than 300 mm high to edges of slabs shall be measured by the linear metre.

The rates for formwork shall include for the cost of submission of details providing and transporting all materials for formwork and falsework, erection including provision of supports, fillets and chamfers 75 mm and less in width, bolts, ties, fixings, cutting to waste, drilling or notching the formwork for reinforcement where required, working around pipes, ducts, conduits and waterstops, temporary openings, cleaning, dressing, stripping, filling bolt holes and any remedial work and for complying with Clauses 5.08, 5.10, 5.17, 5.18, 5.19 and 5.21 to 5.27 inclusive of this Specification.

5.38.6(b) Item: Waterstops

Unit: m of each type

Waterstops shall be measured by the metre run of each type.

The rate for waterstops shall include for the provision installation, jointing, any sealants required at the face of the concrete and for placing and compacting concrete around the waterstop.

5.38.7.Item: Mortar

Unit: m²

Mortar used for bedding base-plates and the like shall be measured by the square metre as the area of the base plate at the specified nominal thickness of bedding.

Mortar used in filling bolts pockets and the like shall not be measured separately and the cost shall be included in the rates for the bolts. The rates for mortar shall include for the cost of providing and placing the mortar and of complying with the requirements of Clauses 5.14 and 5.20 of this Specification.

5.38.8. Item: Admixtures, workability and hardening agents

Unit: as per instruction of the Engineer

Where required by the Special Specification admixtures, "Workability and hardening agents will be measured and paid for in accordance with the Engineer's Instructions.

5.38.9.Item: Reinforcement

Unit: tonne of each type for each range of diameters. Reinforcement shall be measured separately for each of the following ranges.

- (i) of diameter equal to or less than 16 mm.
- (ii) of diameter greater than 16 mm.
- (iii) Steel fabric reinforcement shall be measured in accordance with Clause 5.41.11 (k) of this Specification.

Steel plain and deformed bar reinforcement shall be measured by the tonne and shall be the calculated weight of the steel required including splice lengths shown on the Drawings. No allowance shall be made in the measurement for rolling margin or cutting waste. The density of Steel shall be taken as 7,850 kilograms per cubic metre.

The rates for reinforcement shall include for the cost of providing, cutting to length, splice lengths additional to those shown on the Drawings, laps, bending, hooking, waste incurred by cutting, cleaning, spacer blocks, provision and fixing of chairs or other types of supports, welding, fixing the reinforcement in position including the provision of wire or other material for supporting and tying the reinforcement in place, bending reinforcement aside temporarily and straightening, placing and compacting concrete around reinforcement and for complying with the requirements of Clause 5.28 to 5.31 inclusive of this Specification.

5.38.10. Item: Fabric reinforcement

Unit: m² of each type

Steel fabric reinforcement shall be measured by the square metre and shall be the calculated area excluding any allowance for laps.

The rate for steel fabric reinforcement shall include for the costs stated in Clause 5.41 (j) of this Specification.

5.38.11. Item: Precast Units

Unit: no. of each type

Precast units shall be measured by the number of each type instructed unless otherwise specified in the Special Specification.

The rate for precast units shall include for the cost of all the materials, forming, and placing units, complying with the requirements of Clauses 5.32 to 5.40 inclusive and with the relevant Clauses of the Special Specification.

No separate measurement or payment will be made for formwork reinforcement or

prestressing tendons to precast units.

6. STRUCTURAL STEELWORK

6.2. General

The fabrication and erection of all structural steelwork shall be under the constant supervision of competent and experienced personnel. All workmanship shall be in accordance with the best modern workshop practice and only skilled workers trained and experienced in steel fabrication and erection shall be employed.

6.3. Applicable Standards

The supply, fabrication and erection of structural steelwork shall be in accordance with the provisions of the relevant clauses of the following British Standards:-

BS 4 Structural steel sections.

BS 4848 Hot rolled structural steel sections.
BS 153 Steel girder bridges,

Part 1 - Materials and workmanship and Part 2 - Weighing, shipping and erection.
BS 4360

Weldable structural steels.

BS 4395 High strength friction grip bolts and associated Parts 1&2 nuts and washers for structural engineering (metric series).

BS 4604 The use of high strength friction grip bolts in structural steelwork.

BS 2708 Unified Black Square and hexagon bolts, screws and nuts (UNC and UNF threads).

BS 4190 ISO metric black hexagon bolts screws and nuts.

BS 3692 ISO metric precision hexagon bolt screws and nuts.
BS 4320 Metal washers for general engineering purposes.

BS 5135: Metal arc welding of carbon and manganese steels.
BS 638 Arc welding plant, equipment and accessories.

BS 639 Covered electrodes for the manual metal-arc welding of mild steel and medium tensile steel

BS 4870 Approval testing of welding procedures, Part 1 Fusion welding of steel.

BS 4871 Approval testing of welders working to approved welding procedures, Part 1-Fusion welding of steel.

BS 5493 Protective coating of iron and steel structures against corrosion.

6.4. Materials

All structural steel shall be to the Grade as defined on the Drawings and shall comply with the requirements of BS 4360 in every respect.

Mill certificates shall be supplied to the Engineer in duplicate to confirm the mechanical and chemical properties.

Steel for headed stud shear connectors shall have a minimum yield stress of 385 N/mm² and a minimum tensile strength of 495 N/mm².

6.5. Storage of Materials

Structural steelwork whether plain or fabricated shall be stored above ground on

platforms, skids or other supports and in such a way as to prevent pools of water forming on the ground. It shall be kept free from dirt, grease and other deleterious material and shall be protected as far as is practicable from corrosion. The time limits for outside storage of unpainted or primed steelwork shall be as detailed in the Special Specification.

6.6. Fabrication

Fabrication shall generally be in accordance with the requirements of BS 153 Part 1, Workmanship. Rolled material, before being processed, must be straight or flat. Straightening or flattening, where required and where permitted by the Engineer, shall be accomplished by a process not harmful to the material.

The Contractor shall submit to the Engineer for his approval two sets of shop drawings with calculations as appropriate and the Contractor shall not commence fabrication until written approval has been given by the Engineer. The Engineer will give comment or approval within 28 days after receipt of the shop drawings and calculations. Such approval shall not relieve the Contractor of any of his responsibilities under the Contract.

Following approval of the shop drawings the Contractor shall supply to the Engineer a further four copies of each drawing for the use of the Engineer and the Employer.

The components of various members of the structure shall be placed in jigs of approved design and all welding shall be carried out in accordance with Clause 6.7 of this specification. Every precaution shall be taken to prevent distortion.

6.7. Preparation of Edges and Ends of Plates

Edges and ends shall be either:

6.1.1 left as rolled, sawn, machine cut, machine flame cut;

6.1.2 hand flame cut and ground to a smooth profile; or

6.1.3 for stiffeners and gussets not exceeding 12 mm thick, sheared and subsequently ground to a smooth profile.

Where ends of stiffeners are required to be fitted, they shall be ground to be in contact with the flanges over 80% of the area of stiffener.

After shearing or flame cutting of plates, one of the following requirements shall be satisfied:

a) The hardness of the out edge shall not exceed 350 HV 30 of BS 427;

b) the cut edge is incorporated in a weld;

c) the material from the edge is removed by machining or grinding to demonstrate that the hardness of the edge is less than 350 HV 30 of BS 427;

d) the edge is softened by an approved heat treatment and is shown to be free from cracks by crack detection procedures; or

e) the material is Grade 43 steel and is not greater than 40 mm thick and the edge preparation is by machine flame cutting.

6.8. Welding

Welding will be permitted only where shown on the Drawings and the agreed shop drawings.

All welding operations shall comply with the requirements of BS 5135. The details of all welds shall be arranged to achieve the most satisfactory welding procedure. The details of the welding procedure shall be submitted to the Engineer for his approval and no welding may commence without the prior approval of the Engineer. No departure from an approved procedure may be made without the prior approval of the Engineer. Welding procedure details to be submitted to the Engineer shall include the following: -

- Welding position.
- Fusion face preparation. Pre-heating.
- Electrode make, type and size and mechanical properties, number and arrangement

of runs

- Welding current
- Arc energy
- Method of back grouting and sealing
- Proposed methods of quality control and testing of welds

Welding shall be carried out under the supervision of an experienced and competent supervisor in accordance with the requirements of BS 5135. The welders shall be tested in accordance with the requirements of BS 4871 prior to the commencement of the work.

The Contractor shall carry out trials of the welding procedure in accordance with the requirements of BS 4870.

Welding plant and accessories shall comply with the requirements of BS 638 and shall be used in accordance with the manufacturer's instructions. The welding plant shall be capable of maintaining at the weld the current and voltage specified by the manufacturer and in accordance with the welding procedure.

The electrodes shall be selected with regard to the quality of the material to be welded and the optimum performance with the welding procedures and shall comply with the requirements of BS 639. All electrodes shall be stored in their original packets in a dry and preferably heated place adequately protected from the weather and shall be handled with care and in accordance with the manufacturer's instructions. Electrodes and fluxes that show signs of moisture, damage or deterioration shall not be used.

Welds shall be subject to non-destructive examination and testing as specified in the Special Specification.

Welded fabrications and weld quality shall comply with the requirements of the American Welding Society Specification ANSI/AWS D1.1.8L, section 9, PART D

Stud shear connectors shall be subjected to the following tests:-

6.1.4 (a) The fixing of studs after being welded in position shall be tested by striking the side of the head of the stud with a 2 kg hammer and shall pass such test if no part of the weld shows fracture or is dislodged thereby.

6.1.5 Any stud selected by the Engineer shall be capable of being bent by striking the side of the head of the stud with a 6 kg hammer until its head is displaced laterally a distance of approximately 0.25 times the height of the stud from its original position. The stud weld shall not show any signs of cracking or lack of fusion. Satisfactory studs shall not be bent back again.

Studs whose welds have failed the tests given in (a) and/or (b) above shall be replaced according to a procedure to be agreed with the Engineer.

6.9. Bolting

6.9.1. Black Bolts

All mild steel bolts, washers and nuts shall be of the grade as specified on the Drawings and shall comply with the requirements of BS 4190, BS 2708 or BS 3692 as appropriate.

All holes shall be drilled or drilled small and reamed and shall be clean cut without torn or ragged edges. The holes shall be perpendicular to the member and not more than 2mm larger than the nominal diameter of the bolt.

In all cases where the full bearing area of the bolt is to be developed the bolt shall be provided with a steel washer under the nut to avoid any threaded portion of the bolt being within the parts bolted together. Tapered washers of the correct angle of taper shall be provided under all bolt heads and nuts bearing on bevelled surfaces.

6.9.2. High Strength Friction Grip (HSFG) Bolts

HSFG bolts shall comply with the requirements of BS 4395 Parts 1 and 2 and shall be used in accordance with the provisions of BS 4604 Parts 1 and 2.

HSFG bolts, nuts and washers shall be supplied cadmium plated to BS 3382 to a thickness of 5 microns and shall be stamped or otherwise marked with a suitable and permanent mark and the Contractor shall obtain the written approval of the

Engineer to the proposed marks before commencement of the work.

Each HSFG bolt shall be supplied complete with its nut screwed on. washers may be supplied on the bolt or separately and bolts and washers shall be packed in the manufacturers works and delivered to site in waterproof containers and stored under cover in these until required for use.

The method of tightening HSFG bolts shall be either the part turn method, the torque control method or with the use of load indicating washers in accordance with the following:-

HSFG bolts complying with standard	Permissible methods of tightening.
BS 4604 Part 1 and 2	1) Part turn for bolts M16 and above 2) Torque control. 3) load indicating washers.
BS 4604 Part 2	1) Torque control. 2) load indicating washers.

Whatever method of tightening is adopted, the Contractor shall supply to the Engineer full details of the procedures to be adopted which shall be in accordance with the requirements of BS 4604, together with details of the tools and equipment he will be using at Site and the tests to be carried out to determine the tension characteristics of the tools, bolts and the load indicating washers. No bolting shall commence until the Contractor has carried out sufficient site tests to confirm the load/torque/shank tension characteristics of the tools and bolts.

In the case of torque control tightening methods, calibration of the equipment shall be carried out daily before commencing bolting operations in accordance with the requirements of BS4604.

Where load indicating washers are used they shall be of a type approved by the Engineer and used in accordance with manufacturer's instructions.

The general requirements of BS 4604 shall apply to the assembly and use of HSFG bolts with indicating washers including check testing to confirm minimum shank tension is being achieved.

HSFG bolts that have been slackened off after final tightening by any method shall be removed, discarded and replaced.

6.10. Transportation Handling and Erection

Erection shall be in accordance with BS 153 Part 2, Weighing, Shipping and Erection. Structural steel shall be handled with due care at all times and in such a manner as not to cause damage to the steelwork or its protective coatings.

The Contractor shall submit to the Engineer for his approval two sets of drawings and calculations and details showing his proposed methods for transport, handling and erection of structural steelwork including all plant, temporary supports and bracings required to ensure stability and safety during erection. The Contractor shall erect the steelwork, remove the temporary supports and do all the work required to complete the Works in accordance with the Drawings and this Specification. The work shall be carried out in such a manner as will not injure, overstress or disfigure any part of the structure or the foundations and any part injured, overstressed or disfigured shall be removed and replaced or rectified to comply with the requirements of this Specification.

The steelwork shall be temporarily erected at the fabrication works and be subject to inspection by the Engineer before being dispatched to Site.

Drift pins will be allowed only for bringing together the several parts of the structure, and shall not be used in such a way as to distort the work or enlarge the bolt holes.

Bolts in site connections shall not be finally tightened until sufficient of the structure is properly plumbed, aligned and levelled and no subsequent straining into position will be allowed. Finally all bolts and connections shall be systematically checked and tightened.

6.11. Surface Preparation of Steelwork

Surface preparation of steelwork shall be by blast cleaning in accordance with the requirements of BS 4232, second Quality. The maximum amplitude of the blast cleaned surface shall not exceed 0.1mm.

Manual cleaning of structural steelwork including mechanical wire brushing, chipping hammers, vibratory needle guns and the like shall not be permitted except for small parts and then only with the prior written permission of the Engineer.

Surfaces shall be painted with the specified primer paint within four hours of having been blast cleaned.

As soon as the first undercoat has dried, a further stripe coat of paint shall be applied by brush to all edges, corners, crevices, exposed parts of bolts, rivet heads and welds. The stripe coat should have the same specification as the undercoat but be a contrasting shade.

Painted surfaces shall be cleaned of dust immediately prior to the application of further paint. All loose paint, dirt and grit shall be removed and areas contaminated with oil and grease shall be cleaned with emulsion cleaners followed by washing and rinsing - with clean fresh water and followed to dry thoroughly before paint is applied.

In the case of painted steelwork where the interfaces of HSFG bolts are bare steel, the primer coat shall be taken between 100mm and 20mm inside the perimeter of the joint area.

Where paints are to be applied to parent surfaces before making of a joint they shall be stepped back at 30mm intervals commencing at 80mm from welded joints and 100mm from the perimeter of all other joints.

All bolted joints shall be sealed against the ingress of water. Gaps at joints shall be plugged with approved filler and the perimeter of all joints shall be sealed with subsequent coats of paint.

All joints, welds and surfaces affected by welding shall receive the same protective system as applied to the parent surfaces.

Within 14 days of a joint being made and accepted by the Engineer, the parent material, exposed parts of bolts, nuts and washers, weld and affected areas shall be prepared and painted.

6.12. Painting

All paint used in the Works shall be subject to the approval of the Engineer.

All paint shall be supplied from the store to the painters ready for application. Any addition of thinners must be made in the store under the supervision of the Engineer and only as permitted by the manufacturer's data sheet. All the requirements of the manufacturer's data sheet shall be strictly complied with.

Paint shall be applied only to surfaces which have been prepared and cleaned in accordance with the requirements of Clause 6.10 of this specification.

The use of rollers shall not be permitted for the application of paint. Paint shall not be applied under any of the following conditions: -

- (a) When the ambient temperature is less than 4°C.
- (b) When the relative humidity is greater than 90%.
- (c) During fog, rain or mist.
- (d) When any moisture is present or likely to condense on the steel. Each coat of paint shall be free from surface defects.

Successive coats of paint shall have different shades for identification.

The Contractor shall ensure that the proposed application rates shall enable the specified minimum dry film thickness to be achieved. If the total dry film thickness is less than the specified minimum, an extra finishing coat or coats shall be applied until the specified dry film thickness is obtained.

6.13. Paint Systems

The paint system to be used on structural steel work shall be as specified in the

Special. Specification.

6.14. Damaged Surfaces

Any areas of paint which have been damaged following application shall be cleaned down to bare metal and the full specified painting system shall be reapplied. The new paint shall overlap the existing paint by at least 50mm all round the affected area.

Galvanized surfaces damaged shall be repaired either by the use of low melting point zinc alloy repair rods or powders made specifically for this purpose or by the use of at least two coats of a good quality zinc rich paint to BS 4652.

6.15. Internal Bracings and Brackets:

Internal bracings and brackets shall be designed to ensure the strength, rigidity and absolute uniformity of each tank depending on sizes.

6.16. Fasteners:

All bolts used in the assembly of the tank shall be of High Tensile Grade 9.8 for rigid holding. They shall be zinc coated to protect against any rust forming.

6.17. Joint Materials:

A non-toxic strip joining material shall be used between the flanges of tank plates, under the internal brackets and for sealing the cover plates to make all joints completely leak proof.

6.18. Fittings:

The Steel tank shall be provided with suitable standard nozzles either threaded or flanged depending on the requirements. Sizes and orientations are to be provided by the time of ordering.

The tank shall be provided with Inlet, Outlet, Overflow, Drain Vent, Level Indicators and Internal & External Ladder. Any other additional fittings shall be provided on request.

6.19. Measurement and Payment

(a) Item: Structural

Steelwork Unit:
tonne

Structural steelwork shall be measured by the tonne and shall be the weight calculated from the approved shop drawings excluding bolts, welds, washers and all other fixings required. No deduction shall be made in the measurement for splay cuts, notches and holes providing that the area of each is less than 0.1 square meters. No allowances shall be made in the measurement for rolling margin or cutting to waste. The density of steel shall be taken as 7850 kilogrammes per cubic metre.

The rate for structural steelwork shall include for the cost of the following:-

- (i) Design, submission of orders, fabrication drawings, details, calculations and certificates.
- (ii) Provision of all structural steelwork, materials, bolts, nuts, washers, welding rods, and all other fixings; fabrication, including drilling, machining and welding; testing of welds and welders.
- (iii) Temporary erection at the fabrication works for inspection by the Engineer.
- (iv) Surface preparation, painting with specified paint system,
- (v) Inspection, and submission of test reports and certificates.
- (vi) Marking, handling, packing, transporting and storage.
- (vii) Erection, bolting, welding, including temporary bracings, guys, and craneage.
- (viii) Complying with all the requirements of Section 6 of this Specification.

7. PIPEWORKS

7.2. Materials

All pipes, couplings, gaskets, lubricants, seals, coupling machinery etc., necessary for the proper construction of the pipe works as detailed in the Bill of Quantities and drawings shall be supplied by the Contractor.

The Contractor shall be responsible for ensuring that the pipes, couplings and other fittings laid or installed on each section of the work are of the standard and pressure classification specified as appropriate to the circumstances, and are manufactured of the specified materials.

The Engineer reserves his right to refuse any materials that in his opinion is inferior.

The Engineer has the right to test any material upon delivery, and materials found defective shall be replaced forthwith by the Contractor.

If the Contractor procures materials of different specifications in respect of flanges and threads etc. (imperial units-metric units), he shall at his own cost provide all adaptors and other fittings necessary to make connections to the satisfaction of the Engineer.

All materials shall be marked as specified in the relevant current British or ISO Standards for easy identification on site.

Pipes shall be supplied in standard lengths unless otherwise shown on the Drawings.

Specials shall be fabricated to the details shown on the Drawings, using, where applicable, the same materials, welding procedures and protective linings and coatings as are specified for the corresponding straight pipes.

Satisfactory temporary end covers shall be provided for the protection of threads, flanges and the prepared ends of pipes, fittings and specials, and for the prevention of damage to internal linings during transportation and during handling on Site.

7.3. Handling and Storing Materials

The method of transportation, handling and storing of pipes and fittings shall be in accordance with the manufacturer's recommendations.

Pipes, valves, specials and other materials shall be handled, moved, lifted or lowered with the least possible impact. Handling equipment shall be of approved type. In slinging pipes only flat slings shall be used and the use of chain slings, hooks or other devices working on scissors or grab principles shall not be permitted. Pipes shall be slung from two or more points as the engineer may direct and the slinging, lifting and lowering shall be in the hands of a competent and experienced man.

Subject to the requirements of inspection before acceptance, protective bolsters, caps or discs on the ends of flanges or pipes or specials shall not be removed until the pipes or specials are about to be lowered into the trench. Every precaution shall be taken to prevent damage to internal Linings or external coatings.

Pipes in storage shall be supported clear of the ground on approved supports and adequately braced to prevent rolling. They shall not be stacked more than four tiers high without the approval of the engineer. Materials of different classification shall be stored separately.

All pipes and associated material shall at all times be protected from sun and weather to the satisfaction of the Engineer.

The spindle shall not be used lift the valves.

No valves, fittings or specials shall be stacked more than one tier high without the permission of the Engineer, and they shall not be stored in a dirty place or condition and shall not be allowed to become embedded in earth, sand, stone, aggregate, water, fuel, or any other deleterious matter. Great care shall be taken at all times to keep the faces and seats of all valves clean and free from dirt and grit of any kind. No valve shall be closed without at first wiping the faces with a clean cloth dipped in clean oil. The cavity beneath the valve doors shall be thoroughly cleaned by hand. In the event of accidental spilling of bitumen, cement or other matter, they shall be either dissolved or carefully removed by methods that do not involve scraping of the faces.

Valves and their ancillary equipment shall be protected before and after erection against collapse of earthworks, falls of materials, concrete and cement droppings, wood and other matter.

Shortly before laying or fixing any valve, pipe or fitting the Contractor shall in the presence of the Engineer or his representative carefully examine each valve, pipe and fitting to ascertain damage or defect occasioned to the valves, pipes and fittings during loading, unloading, handling, storage and transportation. All damage and all defects revealed by this examination shall be repaired and remedied by the Contractor.

7.4. Laying and Jointing, 7.4.1. Pipes and Fittings

All laying and jointing of pipes except jointing of PVC and Heavy Duty Polyethylene (HDPE) pipes shall be in conformity with CP 310 and CP 2010.

The bottom of the trench or surface of the bed shall be finished to a smooth even surface at the correct level to permit the barrel of the pipe to rest on the surface throughout its whole length between joint and sling holes. If considered necessary by the engineer, fine screened material shall be placed and consolidated in the trench bottom to provide such a bed.

In general, the preparation of the trench bottom and bed shall be completed for a length of one pipe in advance of the pipe-laying.

The bottom of the trench and pipe bed shall be inspected by the engineer and only when passed as satisfactory shall pipe laying commence.

Each pipe shall be laid accurately to line, level and gradient so that except where otherwise directed, the finished pipe line shall be in a straight line both in horizontal and vertical plans.

The levels and gradients shown on the drawings shall be rigidly adhered to unless otherwise ordered by the Engineer.

Where lines of pipes are to be constructed the Contractor shall provide and fix, at such points as may be directed properly painted and securely positioned sight rails, the levels and positions of which shall be examined and checked by the Engineer before the rails are used and as often thereafter as may be necessary.

There shall at no time be less than three sight rails in position on each length of pipeline under construction to any one gradient, and the sight rails shall be situated vertically above the line of pipes, or immediately adjacent thereto.

Pipes shall be lowered singly into the trench, brought to the correct alignment and inclination bedded throughout their length, and properly jointed strictly in accordance with the manufacturer's instructions.

Notwithstanding any flexibility provided in pipe joints, pipes must be securely positioned to prevent movement during and after the making of a joint. On screw and socket joints threads shall be coated with an approved tape to ensure water tightness.

Long radius curves in the pipeline shall be negotiated by deflections taken up in the joints or pipes of one or more lengths of pipes. The deflection at each of the various types of joint of pipes used in the works shall not exceed the manufacturer's specifications.

The Contractor shall take care that all pipes and couplings are clean and free of foreign matter before subsequent sections are jointed.

The Contractor shall obtain from the manufacturer or other approved supplier the necessary tackle required for the proper jointing of the pipes.

The Contractor shall make himself and his employees acquainted with and comply with the instructions issued by the manufacturers of the various types of proprietary joints and couplings for incorporation in the works. The Contractor shall be responsible for obtaining copies of such instructions.

No person shall be employed on the jointing of pipes that is not thoroughly experienced and skilled in the particular work in hand.

Pipes shall not be cut without the permission of the Engineer.

The cut shall be made with an approved mechanical pipe cutter and the edges of the cut shall be clean true and square. Threading of steel pipes shall be done with an approved device.

The normal continuity of construction may have to be interrupted at joints on the pipeline pending the delivery of certain valves or specials. The exact extent of the temporary gap to be left in such instances shall be predetermined, but shall not be fixed without reference to the Engineer to whom the Contractor shall submit for approval a sketch with dimensions showing details of the pipe and jointing arrangement to be adopted to effect ultimate closure. Special care shall be exercised to preserve the accurate alignment of the pipeline over the extent of the temporary gaps which it may be necessary to leave.

Subject to the permission of the Engineer, pipes shall be covered over with approved fill material upon successful completion of laying and joining. Joints shall be left exposed until completion of the pressure test.

Fill for surrounding and cushioning shall consist of uniformly readily compactable material free from tree roots, vegetable matter, building rubbish and excluding clay lumps retained on a 75 mm sieve and stone retained on a 25 mm sieve.

The materials for bedding shall, where ordered, consist of suitable selected materials obtained from the excavations or from approved borrow pits and transported to the location where they are required.

Adequate precautions shall be taken by way of back-filling or other means to anchor each pipe securely to prevent floatation of the pipeline in the event of the trench being flooded or during concreting.

Upon successful completion of the pressure test the pipeline shall be back-filled as specified.

7.4.2. Valves and Specials

Unless otherwise directed all valves, flow-meters, fittings and specials shall be individually supported and their weight shall not be borne by the pipeline, joints or

couplings etc.

All supports for valves and fittings shall be of concrete Class 20 or as specified on the drawings.

Where air valves are to be placed the Contractor shall ensure that the highest point in the main is determined by levelling instrument.

Air valves shall be checked before the main is charged to ensure that the balls and faces are not scored or split, and that there is no dirt or other deleterious materials in the cavities of the body. All air nozzles shall be probed to see that they are clear. No air valve shall be stored before erection in the open in sunlight, or upside down to expose the balls and air cavities.

Scour valves shall be installed at low points in the pipelines as shown on the Drawings. The Contractor shall be in agreement with the Engineer on the exact position of scour valves in particular situations.

Scour valves shall, where possible, discharge in the direction of natural drainage and at such a distance from the Works as to preclude erosion effects.

Unless otherwise directed the controlling valve for a scour shall be installed not more than

1.5 m from the main pipeline.

Ends of all scours shall be protected from intrusion of animals and other foreign matter by suitable screening securely fixed to the pipe end.

Valve penstocks and other fittings shall be securely fixed and where required extension spindles and headstocks shall be properly aligned and fixed in a vertical position unless otherwise directed. They shall be tested for ease of operation and water tightness and valve lands shall be repacked where necessary. Any damaged protective coating shall be made good and they shall be left clean in all respects.

Before each valve is put into service all gears, bearings and spindles shall be oiled with approved oil as recommended by the valve manufacturer. Oil baths shall be topped up to the appropriate levels and all grease nipples charged with grease of approved manufacturer. No deleterious matter shall be allowed to come into contact with the working faces and oil sumps shall be maintained clean.

All valves, fittings, specials shall be fixed with proper sealing tube, gaskets, washers etc. as necessary to the satisfaction of the Engineer.

The rates in the Bills of Quantities shall cover for the supply, storing handling installation and Jointing, together with all bolts, washers, gaskets and lubricants etc.

7.5. Pipes and fittings

7.5.1. Flanges

Where flanged joints are used, flanges shall be in accordance with the requirements of BS 4504: part I or BS 4622 or BS 4772.

The minimum pressure rating shall be for a working pressure of 1.6N/mm (approximately 160 meters head) corresponding to NP 16 flanges. The hydraulic test pressure shall not exceed 3.0N/mm²

The number of holes shall be as follows:

Diameter(mm)	No of holes
80-150	8
200-300	12

350-400	16
450-600	20
650- 800	20

Flanges in pipelines with higher pressure rating shall be for a working pressure of 3.0 N/mm² (approximately 300 metres head) corresponding to NP 30 flanges. The hydraulic test pressure shall not exceed 4.0 N/mm.

Bolts, nuts and washers shall comply with the requirements of BS 4190 and BS 4320. Gaskets shall fulfil the requirements of BS 2494 and shall have a minimum thickness of 2 mm.

7.5.2. Ductile Iron

Ductile iron pipes and fittings shall comply with BS 4772 or ISO 2531, and pipeline distribution network shall be as per CP 2010 Part 3. The pressure rating of the pipes shall be for a minimum working pressure of 2.5 N/mm (approximately 250 metres head) and a hydraulic test pressure of 3.0 N/mm². Care should be taken when the pressure test is carried out not to exceed the permissible test pressure for the fittings installed.

Joint shall be either "Tyton", "Stanlock", "Viking Johnson" of flanged joints as specified in the drawings and the Bills of Quantities. Before any other joint is used written approval of the Engineer must be obtained.

Pipes and fittings shall be coated inside and outside with a hot material complying with the requirements of BS 4147, type 1, grade-d, or with a cold applied material complying with BS 3416: Type II material.

7.5.3. Grey-Iron or Cast Iron

Grey iron or cast iron pipes and fittings shall comply with BS 4622 or ISO/R 13. The pressure rating of the pipes shall be for a minimum working pressure of 1.0 N/mm² (approximately 100 metres head) and a hydraulic test pressure of 1.6 N/mm. Joints, internal and external coatings to be as specified in under the clause of Ductile iron.

7.5.4. Steel pipes

The steel pipe shall conform to B.S. 534 1981, B.S 1387, BS 3600 and BS 3601 and pipeline distribution shall be as per CP 2010 part 2, 1970 and unless otherwise stated specials shall be made from pipes that have been manufactured and tested in accordance with B.S. 3601. Joints shall be screwed and socket for nominal diameters upto 50 mm and flanged or socketed for nominal diameter above 50 mm unless otherwise stated. The type of joint used shall be to the approval of the engineer. The Pipes and specials shall be protected from corrosion internally and externally complying with the requirements of BS 539. The type of protection used shall be to the approval of Engineer.

Welds shall be inspected by radioactive non-destructive testing and tensile and weld bend tests as per BS EN 10224.

Steel Tubes and tubulars with screwed and socket joints shall be covered by the requirements of BS 1387.

Flanges shall be as specified in Clause 7.4.1 and threads as specified in BS 21.

7.5.4.1. Unplasticized Polyvinyl Chloride Pipes

All PVC pipes and fittings shall comply with KS 06-149:1981, ISO 161/1-1976 (E) or BS 3505.

Pipes indicated with a pressure class shall conform to the following minimum working pressures

Class 0.6 MPa	0.6 N/mm ² (marking:red)	(KS classification: A)
Class 0.9 MPa-	0.9 N/mm ² (marking:blue)	(KS classification: B)
Class 1.2 MPa-	1.2 N/mm ² (marking:green)	(KS classification: C) 1.5 N/mm ²
Class 1.5 MPa-	1.5 N/mm ² (marking:brown)	(KS classification :D)

All fittings shall be of pressure class 1.5 MPa and be manufactured of cast iron, PVC or steel.

Joints to be Solvent Cement Joints for nominal sizes equal to or smaller than 50mm and mechanical joints (rubber ring) for nominal sizes equal to or bigger than 80 mm.

For both types of joints the manufacturer's jointing instructions, shall be strictly adhered to.

For solvent cement joints it is essential that the solvent cement used is the correct type, i.e. it shall be purchased from the same factory which delivers the pipes.

The rubber ring joints can be either the Polva type, which incorporates only one rubber ring or loose couplers with two rubber rings. In any case the fittings used shall be purchased from the same factory which delivers the pipes.

If the joint is difficult to fix the manufacturer should be consulted immediately. No cutting or scraping in any of the joints components shall take place.

PVC pipes and fittings shall be stored under cover, which fully protects the material from sunlight.

Acceptable nominal pipe diameters for PVC pressure pipes are 75 mm, 90 mm, 110 mm, 160 mm, 200 mm, 250 mm and 315 mm. 75 mm diameters shall only be allowed when a network analysis shows that the water demand for firefighting is satisfied.

All PVC pipes and fittings shall, prior to delivery, be factory-tested to 4.2 times the specified working pressure, and a certificate to this effect shall accompany all deliveries. PVC products shall be stored away from sunlight and shall be backfilled as soon as practicable after having been laid.

7.5.5. Precast Concrete

Precast concrete pipes and fittings shall comply with BS 556:

Part 2. The laying and jointing of the pipes shall comply with CP 301.

The Contractor shall adopt such measures as may be approved by the Engineer to ensure that every newly laid pipe is concentric with previously laid pipes with which it joins.

Unless otherwise approved by the Engineer pipes shall be laid in an upstream direction and the socket ends shall point upstream.

Before commencing the laying operation, the Contractor shall ensure that the parts of pipe which will come into contact with the jointing material are perfectly clean.

Cement mortar joints for spigot and socket pipes shall be made as follows:-

(1) Before commencing the jointing operation, the socket of the previously placed pipe and the spigot of the new pipe shall be cleaned and thoroughly soaked with water.

(2) The spigot shall be wrapped one complete lap with tarred hempen spun yarn and the new pipe shall be carefully drawn towards the previously laid pipe so the spigot enters to full depth into the socket of the previously laid pipe. The new pipe shall then be adjusted and fixed in its correct position in line, level and gradient and the tarred yarn shall be sealed tightly into the socket.

On completion of this operation, the yarn shall not fill more than one quarter of the total depth of the socket.

(3) The remainder of the socket shall be completely filled with cement mortar consisting of one part of cement to three parts of sand. The mortar filling shall terminate flush with the socket and shall be neatly trowelled to a smooth finish around the pipe.

To assist the curing of the mortar the contractor shall cover the joints immediately after they are made with a layer of Hessian cloth which shall be kept continuously wet during daylight hours and he shall further adopt such other measures as the Engineer may direct

Provided the Contractor has the Engineer's written consent other means of jointing may be adopted, e.g., rubber ring-joints. The Engineer's instructions in regard to other jointing materials must be strictly complied with.

7.5.6. Glass Reinforced Polyester Pipes (GRP)

The GRP pipes shall be of International Standards Organization ISO 10639 and EN 1796 for potable water transfer. Joint testing shall meet ASTM D4161 AND EN 119 Standards. Long Term Stiffness shall meet ISO 10468 and Long Term Bending shall meet ASTM D5365 Standards. Production of GRP pipes shall be through controlled manual process to ensure high quality pipes.

7.5.7. High Density Polyethylene Pipes (HDPE)

The (HDPE) pipes shall be of International Standards Organization ISO 4427 and BS 6437 & 6730 for Potable water Stress Regression Tests to comply with ASTM D 2837. Density 955kg/ m, pipe classes and markings shall correspond to those of uPVC pipes. Pressure testing shall be as per manufacturer's recommendation and as approved by the Engineer. All transitions from HDPE pipe to GI, Steel, uPVC or Cast Iron shall be as per manufacturer's recommendation and to the approval of the Engineer

Acceptable nominal pipe diameters for HDPE high pressure pipes are 25 mm, 40 mm, 50mm, 63 mm, 75 mm and 90 mm. Under no circumstances may saddles be used with PE pipes. Welded adaptors may also not be used with PE pressure pipes.

7.6. Protection of Pipes

The concrete used for bedding, haunching and surrounding the pipes shall be concrete class 15 unless otherwise ordered by the Engineer. The concrete protection shall have total dimensions not less than those given below.

The various types of concrete protection to pipelines are detailed below:

- i. Bedding concrete shall have a width of at least 300mm bigger than the external diameter of the pipe and shall support at least the bottom quarter of the pipe circumference. It shall have a minimum depth of 100mm measured under the pipe throughout the cross-section.
- ii. Bedding and haunching shall comprise a concrete bed with a minimum width of 300mm more than the external diameter of pipe and a minimum thickness of 150mm below the pipe, and haunching with a minimum thickness of 150 mm on both sides the pipe. The top of the haunching to be flush with the top the pipe.
- iii. Surrounding concrete shall comprise a concrete bed as described above together with 150 mm concrete on both sides and on to the pipe, giving a pipe protection of at least 150 mm concrete everywhere around the pipe.

Concreting of bedding, haunching or surround shall not be done until the pipes have been jointed, inspected and tested. The concrete shall be placed on one side of the pipe only until the flow of material under the weight placed ensures that the concrete is in full contact with underside of the barrel of the pipe throughout its length. The concrete shall be placed in one operation and shall be well worked to a homogeneous mass. The pipe shall be carefully anchored against floatation. All anchorage, haunches, surrounds, etc. shall be placed on and against undisturbed earth or rock as directed by the Engineer.

PVC pipes are laid in suitable bedding material as per drawings. Protection against e.g. load from traffic is carried out by laying of concrete slabs as detailed on the drawings. Special care shall be taken regarding compaction of fill below the concrete slabs.

7.7. Valves and Specials

Where flanged joints are used, flanges shall be specified in clause 7.7.1. Where screwed joints are used, thread shall be complying with BS 21.

Joints shall be flanged for sizes equal to or bigger than nominal diameter 80mm and screwed for small sizes.

The names of manufacturers and the specifications of the products offered shall be provided at the time of tender.

7.7.1. Gate Valves and Sluice Valves

Gate (sluice) valves shall comply with BS 5163.

The valves offered shall be with straight through openings and shall be with double faced cast iron wedges and have two machined gunmetal faces securely fixed into machined recesses.

The body of the valves shall withstand a pressure equal to or greater than the test pressure of the line and the valve seat shall withstand pressure equal to or greater than the working pressure of the pipeline. All gate valves and sluice valves installed in sections of the pipeline having a working pressure below 1 N/mm² shall have a rating of PN 10 (100 metres head). Valves installed in sections of pipeline having a working pressure between 1 N/mm² and 1.6 N/mm² shall be valves with a rating of PN 16.

For pipelines having working pressure higher than 1.6 N/mm² BS 5151 shall apply.

Materials shall be Cast Iron for sizes equal to or bigger than 80 mm, with flanged joints, and Cast Iron or brass for smaller sizes with screwed joints.

The valves shall be with non-rising spindle and shall if not otherwise stated be supplied with handwheels.

Handwheels shall be of cast iron, and shall have cast on the upper end of the rim, words "OPEN" with appropriate direction arrows.

7.7.2. Butterfly-Valves

Butterfly valves shall comply with BS 5155. The valves shall be of the "light shut-off type" and shall be of either the double flanged or the wafer types with metal-to-metal seating.

The minimum service rating shall be PN 2.5. Care shall be taken when installing wafer type butterfly valves to ensure that the door when open does not foul the connecting pipe or any other- adjacently connected valve or fitting.

The valves shall be lever operated and shall be marked with arrows showing "Open" and "Closed" positions.

Where the valve is mounted in a horizontal pipe with the shaft horizontal, it should be fitted in the pipeline so that the lower portion of disc moves in the same direction as the flow when opening the valve.

7.7.3. Non-Return Valves (Reflux or Check Valves)

The valves shall comply with BS 5153, and shall be of the swing pattern type.

The pressure rating shall be NP 16 corresponding to a working pressure of 1.6 N/mm² (160 metres head). Material to be Mechanite Iron or Cast Iron for sizes equal to or bigger than 40mm, and Bronze or Brass for smaller sizes.

The valves shall be installed, on horizontal parts of the pipelines, and shall have an external indication of the direction of flow.

7.7.4. Air-Valves (Small-Orifice)

Standard small orifice type with inlet ferrule screwed 25mm BSP taper male e.g. M/S Neptune Glenfield cat. No. 1250 with an outlet orifice diameter of 2.25 mm and an operating pressure not less than 1.6 N/mm² (16 bar).

For pipelines having working pressures higher than 1.6 N/mm² the valves shall have an operating pressure of not less than 2.5 N/mm² (250-m head).

7.7.5. Air-Valves (Large-orifice and double acting)

Double large orifice air valves as Glenfield cat. no 1271 shall be manufactured of cast iron and shall have a minimum nominal diameter of the inlet of 80 mm. Working pressure shall be not less than 1.6 N/mm² (160 m head).

For pipelines having working pressures higher than 1.6 N/mm² the valves shall have an operating pressure of not less than 2.5 N/mm² (250 -head).

7.7.6. Float-Valves

Working Pressure to be minimum 1.0 N/mm² (100-m head) if not otherwise specified on the drawings and in the Bill of quantities.

Capacities and dimensions to be as specified on the drawings.

Dimensions indicated are the diameters of the inlet to the float

valve. Types: Portsmouth screwed (15 to 50 mm) (BS 1212)

Single or Double Beat Equilibrium Angular, flanged (50 to 150 mm)

7.7.7. Constant Flow Valves

Constant Flow Valves or flow regulators are to be of flexible orifice type or other approved type with an accuracy of discharge flow of plus or minus 10% of the nominal flow rate, at least up to a pressure of 1 N/mm² flow rates to be as shown on drawings,

7.8. Main-Water meters

Woltmann type with metric clock type registration supplied with blank cover to replace mechanism. Ends to be flanged. Where reducers (tapers) are required, special reducers which provide identical overall lengths for varying sizes of meters to be used.

7.9. Penstocks or Sluice Gates

Penstocks shall be single faced cast iron gates with non-rising spindle complete with extension spindle and removable hand wheel all of approved manufacture.

7.10. Draw-off taps and Stop valves

All draw-off taps (bib-taps, hose-taps etc.) shall comply with BS 1010, and shall be made of brass.

If specified in the drawings or Bills of Quantities, the taps shall be chromium plated.

7.11. Auxiliary Works

All works specified in this clause shall be with materials and workmanship

7.11.1. Valve Chambers

Unless otherwise directed or detailed all valves, meters and other mechanical fittings shall be housed in chambers with lockable covers.

Valve work shall be so placed in chambers as to facilitate operation, meter reading etc. through the cover opening.

Chambers are measured in numbers and shall be priced as lump sum items covering all composite work as specified on the drawings inclusive of excavation in excess of trench excavation, concrete supports or valves, anchoring walls and backfilling around the chambers.

The depths stated on the drawings are normal depths. Actual depths depend on depth of pipes.

7.11.2. Thrust blocks and Anchors

If not instructed to do otherwise the Contractor shall provide thrust blocks at all bends, tees, ends and wherever shown on the drawings.

Enlargements shall be excavated in sides and bottom of the trench to accommodate anchorages and thrust blocks.

Concrete thrust and anchor blocks shall be formed in accordance with the typical sections shown on the Drawings or as directed by the Engineer. The additional excavation shall be made after the bends etc. have been jointed and the concrete shall be placed immediately after the completion of the excavation.

The back of supports and blocks shall abut on to solid ground, all loose material being removed before concreting.

The concrete used for thrust and anchor blocks shall be of Grade 20 and shall after placing be kept in view for not less than six hours. No pressure shall be applied in any section of mains until the concrete has cured at least three days.

All PVC material shall be wrapped with two layers of bituminous felt for the entire length in contact with concrete. Thrust blocks are measured in numbers and shall be priced as lump sum items covering all necessary works and materials together with excavation, backfilling and formwork.

Anchoring walls for valves are parts of the valve chambers and are included in the lumpsum for valve chambers.

7.11.3. Road-Crossing

When the contractor encounters a road where a road crossing is indicated on the drawings or where to his opinion, such a crossing is required, he shall immediately inform the Engineer. On receipt of the above information, the Engineer will issue appropriate instructions.

7.11.4. Painting

Painting and other protection of the external and internal surfaces shall be in accordance with, manufacturer's recommendations or as specified in Section 5 of these Specifications.

7.12. Testing of Pressure Mains

Pressure pipelines (together with all specials and valves incorporated in the mains) shall, before being covered, be tested with water as specified in CP 310.

At least two days' notice must be given in writing to the Engineer before pressure testing is commenced.

7.13. Water Pressure Test

The water test pressure to be applied will be 1.5 times the nominal working pressure for the class or pipe being tested. The Engineer however, reserves the rights to alter this figure.

Pressure testing of pipelines is not allowed against a closed valve. Mains shall be filled and tested in section of convenient lengths, which must not exceed 500 metres. Where pipes are laid with steep gradients the length of pipes tested at any one time shall, be as directed by the Engineer.

The ends of pipes under test shall be closed by means of caps or blank flanges provided by the Contractor. Gate valves must not be used for this purpose. All scour valves and air valves shall be replaced by blank flanges before commencement of the test.

After laying, jointing and anchoring, the main should be slowly and carefully charged with water so that all air is expelled, allowed to stand full for several days and then be tested under pressure. The test pressure shall be applied by means of a manually-operated test pump connected to the main and to two parallel installed pressure gauges calibrated at an approved testing laboratory. The test pressure shall be maintained for five hours, and if there is any leakage, it shall be measured by the quantity of water pumped into the main in order to maintain the test pressure.

Nominal diameter	Maximum amount of water Pumped of per hour at 100 m head per 100m length of pipe. Litres
50-mm	0.08
80-mm	0.12

100mm	0.16
150mm	0.24
200mm	0.31
250mm	0.40
300mm	0.48

The permissible leakage of water which is given in imperial units in CP 310 as 0.0375 litres per mm diameter per 1000 m length per 24 hours per 10m head of water.

The above maximum permissible leakage approximately corresponds to the following quantities of water over 100 length of pipe and 100m head 1 N/mm²).

Should leakage of water occur at the joints, the joint shall be reassembled to eliminate such leakage or, should this not prove possible, the contractor shall supply and assemble new joints. Should any pipe or joint burst or should water leak or weep through the body of a pipe or joint the contractor shall forthwith remove the faulty pipe or joint and replace it with an un-faulty pipe or joint. In all above cases, the length under test shall be retested as above described and the process repeated, if necessary, until the pipeline satisfactorily withstands the prescribed test

The Contractor shall provide labour, install and work the test pump, pressure gauges and all other equipment required for the test, and he shall fill the pipes with water and subsequently empty them after the test, all to the approval of the Engineer. Water drained from the pipes shall be discharged in a way that does not affect the stability of the Works or adjacent structures.

The Contractor shall allow for all expenses in connection with testing in his rates for pipelaying.

7.14. Testing of Distribution System

If required by the Engineer the Contractor shall carry out and/or assist with the testing of the completed distribution system as directed by the Engineer in order to establish the flow characteristic of the pipelines as built.

The Contractor shall provide all transport, labour and other assistance requested by the Engineer, and the Contractor shall take delivery, install, remove and make good in connection with the installation of gauges and meters etc. for the purpose of the test.

7.15. Testing of Sewer Pipes

All pipes and fittings shall be tested before being backfilled. The lines shall be tested in lengths between manholes or such shorter lengths as the Engineer may approve and in all cases the tests shall be applied in the presence and to the satisfaction of the Engineer or his representative.

The testing shall be carried out as specified in CP301.

The requirements of CP301 correspond to the amounts of water indicated below.

Nominal diameter (mm)	maximum amount of water added per diameter of pipe 30 min. per 100 m length of pipe
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Ø 100	3.0 litres
Ø150	4.5 litres
Ø 230	7.0 litres

Any length of pipeline which is found to be defective shall immediately be put in a sound and satisfactory Condition by repairing any defective part or if necessary by relaying whole of the defective length and again testing and so on until the test is satisfactory. Any pipe found to be partly or totally cracked after laying shall be replaced by another, unless the engineer approves the adoption of an alternative method of repair.

If the Engineer suspects that a pipeline has been damaged during concreting or backfilling, he may order the Contractor to re-test the suspected length. Should the re-test indicate that the line is no longer capable of withstanding the prescribed tests, the Contractor shall forthwith search for and repair the damage and re-test the pipeline until a satisfactory test is obtained.

All manholes must be constructed to be watertight. In general, manholes will be inspected visually and not be tested, but the Engineer reserves his right to direct the Contractor to test the manholes before backfilling the surrounding excavation in order that any necessary works of repair may be carried out prior to backfilling. Any such tests shall be carried out in accordance with such directions as the Engineer may issue.

The Contractor shall provide ample expanding stoppers for each diameter of pipe to be laid, together with such up stand tubes, U-tubes, pumps, labour and all required testing apparatus to the approval of the Engineer.

The Contractor shall be responsible for adequately strutting stoppers when pipelines are subjected to a water test, and he shall take adequate precautions to ensure against any stopper or strutting being carried into a downstream, pipe when the water is released.

The Contractor shall allow for all expenses in connection with testing in his rates for pipelaying.

7.16. Cleaning and Sterilization of Water supply pipes

The Contractor shall before be handing over and during the Maintenance period clean pipelines, chambers and manholes for all dirt and rubbish.

All pipes shall be thoroughly cleaned and washed out to remove all contamination, and all water from these operations shall be removed and drained away.

Sterilization should be carried out in accordance with CP 310.'

Following the satisfactory cleansing the Contractor shall with the use of a portable dosage system - or by some other approved method introduce a solution of a sterilizing chemical containing chlorine into the pipeline. The solution shall be introduced at a very slow rate and shall be of such strength as to give a chlorine concentration of not less than 50ppm (parts per million) throughout the Length of the pipelines.

All taps on the distribution pipes shall be opened successively, working progressively away from the Place where the solution is introduced. Each tap shall be closed when the water discharged begins to smell of chlorine. The whole system shall then remain charged for 24 hours, after which a test shall be made for residual chlorine. If no residual chlorine is found, the sterilization process will

have to be carried out again, until a satisfactory result is obtained. Finally, the pipes shall be thoroughly flushed out and recharged with supply water.

On completion of the sterilization process the pipes shall be left full of water.

The Contractor shall in his rates for pipe laying include all costs of labour, transport, materials, equipment, chemicals and water necessary for the satisfactory completion of the cleansing and sterilization operations.

7.17. Measurement and payments

a. Pipe- type and size

Unit: m

Different sizes and types pipes shall be measured in linear meter laid. The rate shall include the cost of providing; storing, handling, laying and jointing of pipes. The rates shall include for, cleansing and sterilizing all to the satisfaction of the engineer and complying with the required of clause 7.1 to Clause 7.15 of this specification.

b. Pipe appurtenances and auxiliary works including Anchor blocks and chambers

Unit: No.

Pipe appurtenances and auxiliary works shall be measured by numbers provided and installed. The rate shall include the cost of providing; storing, handling, fixing and constructing and jointing of appurtenances. The rates shall also include excavation, formworks, backfilling and requirements for complying with the required of clause 7.1 to Clause 7.15 of this specification.

8. EXTERNAL WORKS

All materials and workmanship not described in this section are deemed to comply to the relevant specifications of the work in hand contained in other sections of these specifications

8.2. Roads and Paved Areas

Work shall be carried out in accordance with the **Standard Specifications referred to in this document is the Standard Specification for Road and Bridge Construction, 1986 Edition published by the Ministry of Transport and Communications. This document shall form part of the Contract.**

8.3. Fencing

All fencing shall be erected in exact vertical position and to straight lines as shown on the drawings. The materials and workmanship shall comply with the recommendations in BS1722.

8.4. Concrete Posts

Precast concrete posts shall be cast of concrete Grade 20 as specified in Section 4, to the sizes shown on the drawings.

The posts shall be securely placed in preformed holes and cast in concrete to depth as shown on the drawings.

Bracings shall be provided at all corners, and at intervals of not more than 50 metres on straight lines of fencing. Maximum distance between posts is 4.5m concrete posts and bracings are measured in numbers, and the rate shall include for supply, excavation, erection and backfilling.

8.5. Chain Link

The chain link fencing shall be supplied in rolls of 2130mm (7 feet) width and shall be with 65mm mesh of 12^{1/2} gauge, fitted to 4 rows of line wires with binding wire at 130mm centres.

The cranked top of the posts shall be fitted with 3 strands of 12^{1/2} gauge barbed wire with four point barbs at 150mm centres. All members of the fencing shall be hot dip galvanized.

Fencing is measured in linear metres and the rate shall include all waste and cutting, as well as fixings to posts and all line wires, barbed wires and binding wires.

8.6. Gates

If not otherwise stated gates shall be 4 metres wide double leaf gates, made from 40mm galvanized steel tube frame (medium class) with 8 gauge galvanized weld mesh welded to the frame. Bracings, hinges, tower bolts and locking arrangement shall be as shown on the drawings or of other approved type. The top of the gates shall be fitted with 3 strands of 12^{1/2} gauge barbed wire. The price for the gate shall include for the manufacture, installation, all bolts and padlocks etc. and painting all as shown on the drawing. Gate posts made of rolled hollow square sections as shown on the drawings are measured separately.

8.7. Measurement and payments

Roadworks are measured as covered area in square metres. Lines of paving slabs and kerbstones are measured in linear metres, and the rates shall cover for all

cutting, waste and bedding etc.

Fence shall be measured in linear meters constructed. And gates shall be measured in numbers.

9. MECHANICAL AND ELECTRICAL WORKS

9.2. General

The workmanship and materials covered by this section shall include the supply and installation of all pumps, motors, engines and chemical dosers and ancillary equipment.

All materials and equipment shall be obtained from reputable manufactures, who have well established agents in Kenya. The local agents shall be able to provide an efficient service of the equipment and must have ample stocks of all expendable items such as gaskets, filters, fuses, indicator lamps, coils etc.

The Engineer reserves his right to reject manufactures or agents not fulfilling the above requirements.

It is the responsibility of the Contractor to provide evidence that the equipment is in compliance with these specifications, and that the equipment will operate satisfactorily under the conditions under which it is installed. All equipment offered shall comprise a complete installation such as bolts, gaskets, protective screens, belt guards, exhausters, painting etc. all to the satisfaction of the Engineer.

Details of concrete plinths for pumps and motors shall be supplied by the Contractor at least 6 weeks before he intends to install the equipment for the approval of the Engineer.

9.3. Trade Names

Subject to the provision of the preceding paragraph and anything hereafter to the contrary trade names or manufacturer's catalogue numbers are mentioned in these Conditions, the reference is intended as a guide to the type of article or quality of material required. The Contractor may use any article or material equal to type or quality to those herein described subject to the prior approval of the Engineer and at his absolute discretion. The onus of proof as to equivalent quality will rest with the Contractor, whose Tender will be deemed to include for the makes described hereafter.

9.4. Spare Parts

The Contractor shall submit with his Tender a guarantee from the suppliers that he will hold a sufficient number of spare parts as recommended by the manufacturer for the maintenance of the equipment

9.5. Storage of Materials

The Contractor shall provide weather-proof lookable sheds for the safe storage and custody of materials for the Works and shall move such sheds and make good damaged or disturbed surfaces upon completion to the satisfaction of the Engineer.

9.6. Testing

The Engineer shall be entitled at all reasonable times during manufacture to

inspect, examine and test on the Contractor's premises, the materials and workmanship of all Plant to be supplied under the Contract, and if part of the said Plant is being manufactured on other premises the Contractor shall obtain for the Engineer permission to inspect, examine and test as if the said Plant were being manufactured on the Contractor's premises. Such inspection, examination or testing if made shall not release the Contractor from any obligation under the Contract.

The Contractor shall carry out at his own expense any tests he may deem necessary to satisfy himself upon the quality of materials and workmanship.

Performance tests shall be carried out for all mechanical and electrical equipment to ensure that the equipment comply with the specifications.

The duration of the performance tests shall be 24 hours.

The Contractor shall include for the necessary labour and instruments, for carrying out these tests, and he shall be responsible for the discharge of water during tests.

The Contractor shall give the Engineer reasonable notice in writing of the date on and the place at which any Plant will be ready for testing as provided in the Contract. If the Engineer so desires to witness the testing the Contractor will facilitate necessary arrangements to enable the Engineer to attend.

The Contractor shall submit to the Engineer all the relevant manufacturers certified test results and certificates for records.

9.7. Drawings

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

The Contractor shall include in his rates for the preparation of all necessary detail or workshop drawings required for the manufacture and erection of the installation and such drawings are to be submitted to the Engineer for approval prior to the commencement of manufacture or installation.

Upon completion of the Works the Contractor shall submit "as built" drawings to the Engineer for his approval.

The Contractor shall be responsible for any discrepancies, errors, or omissions in the drawings and other particulars supplied by him. If such discrepancies, errors, or omissions are due to inaccurate information or particulars furnished in writing to the Contractor by the Engineer, The Employer shall be responsible. The Employer shall pay any extra cost reasonable incurred by the Contractor due to any alterations of the work necessitated by reason of inaccurate information so supplied to the Contractor.

9.8. Description of Services

The Contractor shall supply, transport, deliver, install, connect, commission and hand over all equipment and materials specified in the Specifications, Drawings and Bills of Quantities, in a clean, complete and in every detail working condition. He shall carry out all tests specified in these Specifications or in relevant British Standards together with any test which might be requested by the Engineer in connection with the use of special materials or equipment. Furthermore, the

Contractor shall provide Guarantee, Initial Free Maintenance, instruction Manual and careful instruction to the Employer's staff.

Cost of all the aforementioned materials and services together with all necessary labour, overheads and profits, duties, sales tax, etc. shall be deemed to be included in the rates entered into the Bills of Quantities.

9.9. Maintenance

The Contractor has the liability for defects and maintains all works, equipment and electrical installations for a period of twelve calendar months from the date that the Works are handed over to the Employer. All expendable items, such as gaskets, filters, fuses, indicator lamps, relays, coils, switches, oils tests etc. are to be supplied by the Contractor.

In case permanent power supply is not made available in time for testing various equipment, the Contractor, if he intends to clear out the site, should make his own arrangement for testing the equipments and should again return to site for final testing when permanent power is made available.

No extra payment will be made for the above.

The Contractor shall be held responsible for and shall make good all defects in materials and workmanship that appear during the maintenance periods. The period of liability shall not end until all defects which appear during the defect notification period have been rectified.

In the event of equipment being out of operation due to breakdown for a duration exceeding one week, the defect notification period for that equipment will be extended with a period of the same duration.

9.10. Initial Maintenance Period

The Contractor shall during the twelve months defect notification period carry out all necessary adjustments and repairs, cleaning and lubricating etc. A report of any work done shall be submitted to the Employer and incorporated in the maintenance records.

The Contractor shall inform the Employer before any routine maintenance inspections are carried out, so the Employer can have staff available to attend. Any item of material found to be defective shall be replaced by the Contractor within seven days of being notified and any results of defective workmanship shall be rectified including the supply of new parts if necessary.

The Contractor shall allow in his contract price for the maintenance and inspection service and shall 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 oils, greases, etc. and parts which are periodically renewed such as relay contacts or parts which are faulty for any reason.

9.11. Maintenance and Servicing after Completion of the Initial defect notification Period

The Contractor shall if requested enter into a maintenance and service agreement with the Employer for a period of up to five years from the last day of the maintenance period.

Such an agreement shall offer the same services specified above under "Initial defect notification Period".

9.12. Maintenance Manual

Upon completion the Contractor shall furnish to the Engineer six copies of a manual containing all the following items: -

a.	Description of equipment
b.	Full operation and maintenance instructions
c.	Valve operation
d.	Fault-finding chart
e.	Emergency procedure
f.	Maintenance and service periods
g-	Lubricating instruction
h.	Colour code legend
i.	Primary and secondary spares
J-	Recording drawings

The manual shall be specifically written and not a standard manufacturer's manual unless approved by the Engineer.

Tags giving instructions are not sufficient. All instructions shall be written into the manual with reference to the drawings. All valves terminals and controls on the plant shall be labelled to correspond with the maintenance and operation manual.

The works shall not be considered to be complete for purpose of taking over until such instructions and drawings have been supplied to the Employer and approved by the Engineer.

9.13. Motors

All motors shall unless otherwise stated be suitable for 415/240 volts, 3 phases, 50 cycles, 4 wires power supply, and shall be executed for star-delta starters as specified.

The motors shall be constructed in accordance with CP 1015, and shall be protected as specified in section 11 - Electrical Works.

The motor speed shall not exceed 2900 R.P.M. low speed motor especially 1500 R.P.M shall be preferred.

The motor shall be foot mounted, squirrel caged, drip-proof, or totally enclosed suitable for an ambient temperature of 30° C, the motor shall be designed for continuous running. Each motor shall be capable of an overload of 10% above its rated output at the rated voltage for a period of one hour without sustaining damage.

The rated output of the motor shall be the maximum horsepower absorbed by the pump under the described condition of head and discharge, plus an allowance for loss of power in couplings etc.

Electrically driven pumps shall if not otherwise stated be directly couple via flexible couplings to the motors, and motors and pumps shall be fitted to common rigid steel frames bolted to concrete plinths.

Proper alignment of motor and pump must be guaranteed.

9.14. Generator

The generator shall be rated 400V, 50 HZ with a prime rating of 200 KVA and a stand by rating of 223 KVA

The applicable voltage range of 380 to 415 Volts and a speed of 1500 rpm, The Generator shall be obtained from reputable manufactures, who have well established agents in Kenya. The local agents shall be able to provide an efficient service of the equipment and must have ample stocks of all expendable items such as gaskets, filters, fuses, indicator lamps, coils etc.

The engines shall be of the diesel type with a maximum speed of 1500 R.P.M designed for continuous running.

The engines shall be suitable for electric start, couplings, tachometer, hand throttle control, hand stop control, silencer, fuel tank for at least 300 hours running of one of the engines and necessary tool kit for minor repair.

9.15. Pumps

The backwash and re-circulation pumps shall be gland packed cast iron horizontal centrifugal volute casing pump type each coupled with appropriately sized 3phase 1450rpm electrical motors by HRC coupling and mounted on a prefabricated steel base plates.

9.16. Backwash Water Pumps

Pump casings shall have interchangeable cast iron wear rings. The impellers shall be of bronze or high grade cast iron dynamically balanced to ensure smooth running. The impeller shaft shall be of steel and fitted with renewable bronze protecting sleeves wherever it is in contact with the pumped water. Pumps shall use Gland Packing for seals, and gland packing for 2 years of operation shall be provided during commissioning. It shall be stated in the tender documents if other materials are offered.

9.16.1. Re-circulation Water Pumps

Pump casings shall have interchangeable cast iron wear rings. The impellers shall be semi open impellers suitable for pumping sludge. The impellers shall be of bronze or high grade cast iron dynamically balanced to ensure smooth running. The impeller shaft shall be of steel and fitted with renewable bronze protecting sleeves wherever it is in contact with the pumped water. Pumps shall use Gland Packing for seals, and gland packing for 2 years of operation shall be provided during commissioning. It shall be stated in the tender documents if other materials are offered.

The pumps will be installed in the pump house on concrete plinths and connected to electric power through a wall mountable control panel with switchgear that composes among others; star-delta starters, voltmeters, ammeters, phase failure protection, "ON-TRIP-OFF" indicator lamps, auto & manual "ON - OFF" selector switches.

All pipe types and size used in installation of the pumpsets shall be flanged, and price shall include for the necessary tapers, gaskets, bolts, etc. for connecting up to the pipe diameters shown on the drawings.

The total efficiency of pump and motor shall be as high as possible and NPSH for pumps shall be as low as possible. The pump type and size shall be chosen so as to ensure that the pump is working with an efficiency of not less than 90% of the peak efficiency.

Performance curves, efficiency curves and power demand curves shall accompany the Tender, with clear indicator of the capacity and efficiency for the pump with

the specified head.

Operation of the pumps shall be 2 duty pumps and 1 stand-by.

The backwash pumps shall be capable of raising the water from the clear water tank to the elevated backwash water tank. The re-circulation pumps shall be capable of raising the water from the backwash water lagoons back to the water inlet chamber at the beginning of the water treatment works.

The backwash and re-circulation pumps shall be commissioned and handed over to the Engineer with 5 sets of operating instructions manuals and 2 years' worth of spares. The pump casings, bearings, shaft, impellers and gaskets must be executed of materials suitable for many years' continuous operation in a water system. If materials other than cast iron, bronze or stainless steel are included in the pump, it cannot be approved unless a written guarantee for 10 years' performance is produced, giving free replacement including labour in case of fault.

The pumps shall be of the following technical details:

Pump	Q (m ³ /hr)	Head (m)
Electrical high lift pump set	300	300
Electrical submersible pump	150	100
Electrical submersible pump	92	67

9.16.2. Design

The pumps comprise of a horizontal volute casing, single stage with power ratings and main dimensions to EN 733 up to DN 200. Shaft shall be replaceable shaft protecting sleeve in the shaft seal area. Volute casing and impeller shall have replaceable wear rings. Volute casing shall have an integrally cast pump feet. Bearings shall be deep groove ball bearings, grease lubricated.

The shaft seal shall be gland packing. Other features shall include: Surface cooled, three phase squirrel cage motor; IP 55 Enclosure; thermal class F with temperature sensors and 3 PTC resistors; HRC coupling; contact coupling guard as per EN 294 and a base plate that shall be sectional steel/ folded steel plate/ fabricated sectional steel for the complete unit (pump and motor) in torsion resistant design.

9.17. Chemical Dosing Equipment

The chemical dosing equipment shall consist of dosers, tubes and connections as shown on the drawings.

The type or principle of dosing shall be as per ProMinent's "Sigma/3 Control Type (S3Cb)" or of a similar approved type.

The prices entered in the Bills of Quantities shall cover for the complete installation (chemical tanks excepted). Any item not mentioned in the Bills of Quantities shall be deemed to be covered by the other rates.

Pump Details are as follows

	Delivery Rate at max back pressure	
Type of Pump	bar	l/h
Chlorine Dosing	7	500
Alum and Soda Ash	4	1,040

Chemical dosing rates shall be as follows: Alum Dosing Pump- 1m³

/hr

Soda ash Dosing Pump-

1m³/hr

Chlorine Dosing - 0.5m³

/hr

9.18. Pressure Gauges

The pressure gauges shall be mounted on the delivery side of pumps. The gauges shall be in metric units complete with necessary fittings and isolating cock. The gauges shall be fitted with dampening fluid.

9.19. Electrical Works

9.19.1. General

The quality of materials and workmanship specified in this section is for all items forming part of the electrical installation as shown in the Drawings, Bills of Materials and these Specifications.

9.19.2. Regulations

All the Electrical Works shall be carried out strictly in accordance with the following:

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i) The 13th Edition of the "Regulations for the Electrical Equipment of Buildings" issued by the Institute of Electrical Engineers of Great Britain with Kenya amendments.

ii) The Licensee's By-Laws

iii) The Government Electrical Specification (G.E.S. No 1 and No. 2).

iv) The Power Act

v) Relevant British Standard Specifications and Codes of Practice published by the British Institution (hereafter referred to as BS and GP, respectively).

vi) The Specifications

vii) The Contract Drawings and the working drawings, produced by the Contractor and approved by the Engineer.

viii) The Engineer's instructions

The Contractor shall undertake all modifications demanded by the authorities in order to comply with the regulations, and produce all certificates, if any, from the authorities without extra charge.

After completion of the work, the Contractor shall deliver a complete set of "as built" drawings showing the complete installation including all alternations and modifications. The set of drawings shall include but is not limited to all floor

plans and diagrams.

9.20. Materials

All materials, fittings and accessories are to be new and in accordance with the requirements of the current rules and regulations where such exist, and with the relevant British Standard Specification.

Uniformity of type and manufacture of fittings or accessories is to be preserved as far as practicable throughout the whole work.

Wherever in this Specification the practice is adopted of specifying a particular item as 'similar' to that listed in a particular firm's catalogue, it is to be clearly understood that this is to indicate the type and quality of the equipment required. No attempt is being made to give preference to the equipment supplied by the firm whose catalogue is quoted.

Where particular manufactures are specified herein, no alternative makes will be considered without weighty reasons and the Engineer shall have the right to reject any other makes.

The Contractor shall if required by the Engineer submit samples of materials for their approval before placing an order.

The Contractor will be entirely responsible for all materials; apparatus, equipment etc. furnished by him in connection with his work, and shall take all special care to protect all parts of finished work from damage until handed over to the Employer.

The work shall be carried out by competent workmen under skilled and experienced supervision. The Engineer shall have the right to have any part of the work taken down or changed at the Contractor's expense which is executed in an unsatisfactory manner.

Such materials supplied by others for installation and/or connection by the Contractor shall be carefully examined before installation and connection. Any defects noted shall immediately be reported to the Engineer.

9.21. Workmanship

The routes of services and approximate positions of apparatus are shown on the Contract Drawings, but their exact positions shall be determined by approved dimensional details on working drawings or on site by the Engineer in consultation with the Contractor.

The Contractor shall ascertain on site that his work will not foul other services and in all cases the services through the ducts must be readily accessible for maintenance. Any work which has to be re-done due to negligence in this respect will be his responsibility.

The Contractor will be deemed to have allowed in his tender for locating terminal points of services e.g. lighting switches, socket outlets, lighting points) in positions 1 metre horizontally and vertically from the locations shown on Contract Drawings. Within these limits no variation in the Contract sum will be made unless the work has already been executed in accordance with previously approved working drawings or with the Engineer's approval.

The Contractor will be responsible for the provision of all cable ducts and trenches and for their installation, unless otherwise stated in the Specification or Contract Drawings.

The Contractor shall include in his tender for the plugging of all walls, ceilings and

floors to facilitate the fixing of the conduits accessories and all other portions of the electrical installations. Any purpose made fixing brackets shall also be provided and installed by the Contractor.

The Contractor shall also be responsible for ensuring that runs for floor or wall chase, holes to be cut or left, will be marked out at the appropriate stage of the structural works.

The Contractor shall be responsible for all cutting away and making good.

The Contractor shall pay particular attention to the fixing and alignment of switch, socket, telephone and similar boxes.

Where conduits are concealed, the boxes shall be in an exact position relative to the finished plaster or such other finish as may be applied to enable cover plates to be accurately positioned

9.22. Main Switchboard

The main switchboard shall be freestanding type switchboard, with front access.

The switchboard shall be constructed, fully wired and checked out at the factory and shall require a minimum of installation work on site. Modular construction shall be used wherever practicable and provision shall be made for simplified servicing, replacement and maintenance throughout without major dismantling.

The enclosures shall be suitable for containing circuit breakers, motor starters and metering equipment from Kenya Power. Where spaces on the switchboard are provided for future circuit components, all ancillary parts shall be installed initially. Full safety precautions shall be provided in all cases.

The switchboard shall be dust and vermin proof and shall have a flexibility of unit arrangement so that extension in the future is possible

Provision for conduit and cable entries shall be made at both top and bottom.

Removable insulated shields shall be provided for protection against contact live parts. All panel components shall be of a sufficient mechanical strength to withstand the influences of short circuits.

All bus-bars and bus-bar connections shall consist of high conductivity copper or aluminium and be provided in accordance with BS 159. The bus-bars shall be clearly marked with the appropriate phase and neutral colours which should be Red, Yellow and blue for the phases and Black for the neutral. The bus-bars shall be so arranged in the switchboard that extension may be made in the future on both sides. Bus-bars shall be rated at the nominated current of the main switch in their entire length.

All wiring within the panel shall be orderly laced and bonded to the panel structure, wiring insulation being coloured according to the colour code. Where single core cables are used special care shall be taken to prevent hysteresis.

A high conductivity copper earthing bar shall be provided for the full length of the board and all fuse switch units and circuit breakers shall be bonded to this bar.

A wall mounted steel cabinet with a complete set of spare fuses for the main switchboard shall be provided by the Contractor.

All switches, switch fuses, circuit breakers etc. shall be numbered with engraved plastic labels in white letters on black background.

Where wiring passes through holes in metal works, protection by rubber pushes shall be provided.

9.23. Switchgear

Control voltage of all contactors, automatic switchgear and motor protection gears shall be 220V to 250V. The short-circuiting capacity of all circuit breakers, switch gears and motor control gears shall be in accordance with BS 5419.

All fused switch units shall be supplied and installed complete with Class 'Q' H.R.C. cartridge fuse links complying with BS 88, and shall be contained in metal clad, dustproof, gasket sealed individual enclosures with non-detachable steel operating handles which shall be capable of being locked in the 'off' position.

The fused switch units shall have fault ratings at least equal to the fault rating of the switchboard in which they are to be installed.

Moulded case circuit breakers (M.C.C.B) shall comply with BS 4752 and the following requirements:

8.1.1. Each M.C.C.B shall be triple pole with pole internally ganged and operated by one central toggle.

8.1.2. Each pole shall have a separate thermal and separate magnetic tripping mechanism, both of which shall preferably be adjustable. The toggle assemblies of all three poles shall be internally mechanically interlinked for simultaneous isolation of all three poles under fault conditions, and be so arranged that the overload tripping characteristics calibrations of each pole shall be completely unaffected by the loading of its neighbouring pole or poles.

8.1.3. The tripping mechanisms and calibrations shall be unaffected by fluctuating and high ambient temperature. The M.C.C.B.'s shall have a certified short circuit breaking capacity of at least 15,000 Amps (at 480 Volts and 0.3 power factor).

8.1.4. Circuit breakers of 100A frame size larger shall have interchangeable over current trip units and adjustable instantaneous trip units.

9.24. Motor Starters

Motor starters for the backwash pumps shall be automatic star delta type fitted with double pole incoming mechanically interlocked circuit breaker housed in a damp and dustproof steel enclosure.

Overload protection shall be provided by a solid state current operated relay as manufacture Omron or equivalent. Backwash pumps shall be stopped automatically by use of float switch installed inside the elevated tank. Two spare relays together with two current connectors shall be provided by the Contractor.

Terminals shall be easily accessible and have adequate clearances between phase and earth. Each starter shall be fitted with start/stop push buttons with indicator light for running.

9.25. Distribution Boards

The distribution boards shall be as shown on the relevant drawings. The distribution boards are specified as Crabtree metal-clad for flush or cubicle mounting.

Where the requirement for miniature circuit breakers is indicated on the Drawings, the distribution boards shall be fitted with moulded thermo-plastic units of the combined thermal overload and magnetic short circuit tripping type to BS 3871 Part I having clearly marked 'ON' and 'OFF' positions. MCB's of all ratings shall have a minimum short circuit current breaking capacity of 3,000 A for single

pole breakers and 4,000 A for triple pole breakers.

9.26. Wiring

All wiring must be carried out in P.V.C single core, copper cables to British Standard.

The wiring throughout shall be carried out by looping cables from point to point and no tees or other joint will be permitted. The entire wiring shall be so organized that later change and renewal can take place without cutting down structural parts. The Contractor must allow in his Tender for all measures of efficient fixing of all wiring items.

The Contractor shall comply with colour code requirements of the regulations. Low voltage cables and medium voltage cables shall be enclosed in entirely separate conduits.

All cables shall be drawn-in after the installation of the entire conduit system, and after plaster has dried out. Draw wires shall not be threaded in at the time of conduit installation.

Great care shall be taken to ensure that no crossed cables are allowed to enter conduits.

9.27. Cable and Conductors

All cables shall be delivered to the site in their original packing with all seals intact.

Cable dimensions shall comply with the rules and regulations and with the information given on the Drawings or in the Specification.

All cables shall conform to relevant British Standard. No cable dimensions smaller than 1.5sqmm for light and control circuits shall be used.

Where aluminium cables are connected to copper or brass elements in switchboards, etc., an anti-corrosive paste shall be used.

Common saddles shall be used where cables are grouped. All cables shall be terminated with suitable compression type cable glands of the correct size.

All low voltage cables shall be thoroughly soldered or joined with connectors of absolutely reliable type, which hold the conductors in a firm grip, without damaging the wire and without any possibility of vibrating loose.

Underground cables shall be laid in trenches excavated at a minimum depth of 500mm below ground level in the following manner:-

The Contractor shall trim the trench bottom level and if in hard material shall lay 75mm of sand. Cables shall be laid and covered by a further layer of sand to provide 75mm minimum cover. Interlocking concrete or other approved cable covers indelibly marked 'DANGER HAT ART shall be provided and laid on the sand covering by the Contractor. Backfilling of the trench shall then be completed.

Cables shall be separated by minimum 50mm of sand filling and kept a minimum of 250mm from other services.

Cables shall cross roads and enter buildings by means of 100mm diameter pitch-fibre or similar non-corrosive pipes. These shall be laid at a minimum depth of 350mm and extend a distance of 600mm on either side of road, etc. The ducts shall be provided and laid by the Contractor. The Contractor shall supply and install concrete marker posts at each entry into building, each change of direction, each road or pathway crossing and throughout the length of the cable at intervals not exceeding 50 metres. Underground ducts must be trained and ducts entering buildings shall be sealed in the end nearest to the building.

The position of all cable markers shall be agreed with the Engineer before installation.

9.28. Conduits

Plastic conduits shall be of best quality new super high impact grade, heavy gauge Class A rigid PVC, unplasticised conduit, suitable for plain connection. Conduits badly formed or bent or damaged in any way must not be used. Conduits not cast or concealed shall be galvanized steel conduits of heavy gauge class B welded and screwed steel and shall comply with British Standards.

In no case shall conduits smaller than 20mm be used:

Conduits to be concealed in structures cast in-situ shall be secured to the steel reinforcement work with heavy binding wire, spaced not more than 900mm to prevent movement of the conduit and conduit boxes during the pouring and vibrating of the concrete. Outlet boxes shall be prevented from ingress of concrete, and all boxes shall be fixed to the shuttering with nails or other measures, which must not be visible after removal of the shuttering unless they later can be concealed, e.g. plaster. Conduit shall be installed after the first grid of steel reinforcement work has been securely fixed.

All open ends of conduit shall be protected by coupling plugged with a suitable non-metallic stopping plug. Conduit run in chases in walls or the like shall be fixed by means of mild steel hooks or saddles spaced at not more than 900 mm where the conduit is concealed behind the plaster, it shall be sunk to a depth of 10mm below finished plaster level before application of the plaster.

Conduit fixed to the surface of walls or ceiling shall be fixed by spaced bar saddles fixed not more than 900mm apart. Surface conduit shall also be fixed at 200 mm from boxes, the boxes themselves being securely fixed. Where such an arrangement of boxes and saddles would prove to be both unsightly and unnecessary short lengths of conduit not exceeding 900mm between boxes need not be secured further than by connection to the adjacent boxes. In such cases, the engineer reserves the right to insist upon having additional fixings provided, should he for any reason whatsoever consider additional fixings necessary special care shall be taken to prevent dirt and plaster to enter any section of the conduit system.

All bends in conduits shall be formed for any decrease or increase of the cross section diameter of the conduits. The radius of the bend shall not be less than as indicated by the British standards. For concealed work, this radius should be increased. No manufactured tees, elbows and bends will be permitted. All conduits shall be thoroughly cleaned for sharp edges. The conduits shall be installed avoiding unnecessary bends or changes in direction. Conduits shall be laid in straight lines.

Where straight rows of conduit are installed, inspection boxes shall be placed at not more than 15m intervals. There shall be not more than 4 easy bends or 2 right angle bends between boxes. In surface conduit system, inspection bends may be where it seems convenient to replace inspection boxes but only with permission from the engineer.

Not more than 6 final sub-circuit cables shall run in conduits feeding outlet boxes. Not more than 8 cables running straight back to the distribution board shall be enclosed in one conduit.

Sub-mains shall not be enclosed in the same conduit as other circuits. Lighting sub-circuits shall not be enclosed in the same conduit as single phase sub-circuits shall not be enclosed in the same conduit as three phase sub-circuits.

9.29. Boxes

All conduit boxes in connection with plastic conduits shall be of plastic.

Boxes installed externally shall be galvanized and where exposed to direct weather conditions, they shall be compound filled.

All metal boxes shall be fitted with an earth terminal.

Deep boxes or extension rings on standard circular boxes shall be used where necessary in order to bring the front of each box flush with the ceiling or wall. All screws for holding boxes, lids, etc., in position shall be screwed in. Adaptable boxes shall be screwed by minimum four screws. Conduits shall enter such boxes by means of conduit sockets. Joint boxes without connectors will not be allowed.

All boxes shall match to the equipment installed in the box and genuine parts produced by the same manufacturer shall preferably be used.

All necessary screws, plugs, bolts and other fixings for electrical equipment must be supplied by the Contractor and included in his tender. All fixings in concrete or stone structure shall be by means of rawl plugs or similar plugs in elastic.

All spare ways in junction boxes and the like left for possible future extension shall be fitted with stopping plugs.

9.30. Light fittings

All light fittings shall be supplied by the Contractor. The Contractor shall include in his tender for clearing, installation, connection and supply of light sources in accordance with schedule of light fittings and drawings or as directed by the Engineer.

Fluorescent fittings shall except where otherwise specified be phase compensated by means of a phase capacitor, LC coupling or M coupling. Where earthing of light fittings is necessary, it is to be effected without using chains or other rigid supports as conductors. All light fittings shall be cleaned and installed in complete working order before handing over.

9.31. Security Light Fittings

All external security light fittings shall be controlled by a photocell contactor located as shown in the relevant drawings. The photocell unit shall be fixed at 2000 mm above ground level on either north or south of external wall of indicated building.

9.32. Light switches

Light switches shall be 5 or 20 Amp according to the load switched.

They shall be as manufacture Crabtree with ivory colour moulded covers. They shall be suitable for switching inductive loads and mounted in pressed steel boxes on adjustable grids. They shall be installed at a height of 1400mm above finished floor level.

9.33. Meter Boxes

The Contractor shall supply and install a standard single or Dual Tariff Meter box where called for on the Contract Drawings. He shall also provide the necessary conduits for the Kenya Power Ltd, service cable entry.

9.34. Power Installation

The installation for power shall be concealed in walls and floors in PVC conduits. Precise positions of these and control switches shall be ascertained by the contractor.

The Contractor shall supply, fix and connect isolators to equipment as shown below.

The tender price shall be based on the following heights for isolators and socket outlets, unless specifically stated otherwise on the drawings.

Isolators 1400mm above -finished -floor level.

Socket outlets -flush at 250mm above finished floor level.

All socket outlets jointed above worktops shall be flush mounted at 150mm above worktop.

The motor installation shall include isolating switch and terminating box fixed at the wall 1400mm. Flexible cable shall be provided between the box and the terminal box at the motor. The flexible cable shall be installed with sufficient coils to enable "tong-test readings" for each phase.

All adaptors shall be solid bronze or brass pattern with standard thread.

9.35. Earthing and bonding

Earthing and bonding shall be carried out to the requirements of the current 14th edition of the IEE regulations and GES land 2. In particular, attention is drawn to IEE regulation D5, D6, D7 and D29.

An earth electrical system shall be installed at point adjacent to the main supply intake and at every building served by external distribution System.

Each earth electrode shall be a 12mm diameter copper rod driven to 1300 mm. in rocky soil conditions, where this depth is difficult to obtain the Contractor shall obtain written approval from the engineer for an alternative earth electrode system.

The electrode shall be connected via a green PVC insulated copper to an earth terminal adjacent to the incoming supply, to which all cable armouring, conduit, trucking, switchgear etc. shall be bonded, together with all other metallic incoming services, e.g. -water etc. Provision shall also be made for connection with the neutral of the incoming supply.

Where P.M.E. is approved and after the Supply Authority has made its connection, the Contractor shall similarly connect the neutral of each distributor main to earth at its remote end.

The bonding of other services or connections of neutral to earth shall be made after satisfactory completion of earth continuity and line earth loop impedance test. Tests of the resistance to earth of each electrode system shall also be carried out and the results recorded.

The maximum reading shall not exceed that laid down by Kenya Power Ltd and in any case shall not exceed 2 ohms.

Means shall be provided, e.g. a test clamp, to isolate the electrode from the system for periodic testing. Internal earthing and bonding shall comply with the current edition of the IEE Regulations except that insulated switches and Lighting fittings need not be earthed from a safety aspect. Certain fittings however, may require to be earthed to effect proper operation.

All cable glands for SWA underground type cable, where installed, shall be fitted with an approved earthing washer having a tag for the Connection of an earth

lead. Every such washer installed shall- be connected by an insulated earthing lead to a proper earthing terminal by means of a lug or washers on the adjacent: switcher or other.

9.36. Testing

All tests Prescribed in the 14th edition of the regulations for the electrical Equipment of the institution of electrical Engineers, together with all amendments as applicable, shall be carried out by the Contractor on the completed installation. In addition, testing of all special equipment to the complete satisfaction of the engineer and such other persons or authorities concerned with the installation shall be carried out by the contractor.

Tests may also be required during progress of the Contract for insulation resistance, continuity of a conduit and earth connections and also the ability to withdraw all cables or any, cables from the conduits.

In addition to any tests required by the Supply Company upon completion of the installation, tests for polarity, insulation resistance, earth continuity and adequate operation of all parts of the installation shall as stated above, be carried out by the contractor

The contractor shall provide accurate instruments and apparatus and all labour required for such testing.

All tests must be carried out in the presence of the Engineer or such other person appointed for this purpose, but the Contractor alone will be held responsible to the authorities as to the installations compliance with rules and regulations.

The Contractor will be required to give all notices or details to enable the installation to be tested or inspected. All fees arising from the inspection and in subsequent inspection or re-testing shall be paid by the Contractor.

Duplicate copies of the results of these tests shall be provided within 14 days of the witnessed tests, and the Contractor will be required -to issue to the Engineer the requisite Certificate upon completion, as required under the regulations referred to above.

Any faults, defects, omissions or faulty workmanship, incorrectly positioned or installed parts of the installation made apparent by such inspection or tests shall be rectified by the Contractor at his own expense.

9.37. Handing Over

The Contract works shall be considered complete and the maintenance and defects notification period shall commence only when the Contract Works and supporting services have been tested, commissioned and operated to the satisfaction of the Engineer and officially approved and accepted by the Employer.

The procedure to be followed will be as follows:-

- (a) On completion of the Contract works to the satisfaction of the Engineer, the Contractor shall request the Engineer to arrange for handing over.
- (b) The Engineer shall then arrange a handing-over meeting or a series thereof at the site.
- (c) The Contractor shall arrange with the Engineer and the employer a complete demonstration to be carried out of each and every service and for instructions to be

given to the relevant operating staff and other representatives of the Employer.

(d) The Contractor shall arrange approved Handing Over Certificate and check Lists of all controls and items of equipment, tools, spares and the like.

9.38. Maintenance and Defects Notification Period

The contractor shall maintain the complete electrical installation and associated equipment for a period of minimum 24 months from the date that the installation is handed over to the client. The Contractor shall be held responsible for and shall make good all defects in materials and workmanship that occur during the twelve (12) months maintenance period. The period of liability shall not end until all defects which appear during the maintenance period have been rectified. Any item of material found to be defective shall be replaced by the contractor within seven days of his being notified and any results of defective workmanship shall be repaired including supply of new parts necessary immediately upon being notified. The Contractor shall allow in his tender price for this maintenance and service and shall provide for all tools, instruments, plant and scaffolding, and the transportation thereof, as required for the full correction and full execution of these obligations, and the provision, use or installation of all materials whether they are normal maintenance materials such as oils, greases, sand paper etc. and parts which are periodically renewed such as relay contacts or parts which are faulty for any reason whatsoever excepting always Acts of God such as storm, tempest or flood, lightning and earthquakes; and civil revolt, acts of war and vandalism.

9.39. Electro-Mechanical Equipment

9.39.1. Scope of Supply

The scope of supply comprises the complete mechanical equipment, consisting of the following main parts:

- Piping with Accessories
- Pumps for filter backwashing
- Pumps for recirculation
- Air Blower for Filter Backwashing
- Internal Water Supply
- Aluminium Sulphate dosing
- Soda Ash Dosing
- Calcium Hypochlorite Dosing
- Control Measuring and Safety Devices

It is required to supply, erect, and supervise the erection and delivery in good working order the mechanical and electrical equipment and facilities of the water treatment plant as well as to provide its maintenance during the guarantee period.

The works consist of furnishing all equipment to be complete and ready for operation when installation is completed, even if they are not mentioned in the Specifications. All accessories shall be furnished and included in the Tender Price of the Bill of Quantities/Price List. The Contractor shall furnish all foundation materials required to support and hold the diverse equipment as pumps, piping, armatures, etc.

Spare parts in order to obtain a complete, reliable and operational plant as more fully described hereinafter to get potable water in accordance with the World Health Organization (WHO) Standards.

9.39.2.Piping with Accessories

The scope of works includes all pipes, fittings, valves, connecting and fixing materials with installation. The connecting material (screws, nuts and gaskets) as well as the fixing material (supports, clamps and suspenders) for the equipment which is to be installed in or on the pipes (e.g. valves, dismantling pieces, measurement and control devices) are to be included.

Furthermore, the pressure test, the flushing and the disinfection of the pipes is to be quoted with the relevant items of the B.O.Q. (Bill of Quantities).

Further all parts to be embedded in concrete shall be placed according to the drawings or as instructed by the Engineer at site with written approval.

9.39.3.Design Requirements:

The maximum internal pressure of the collecting well piping is the test pressure. The design pressure shall be PN 10. all parts shall be made of steel.

9.39.4.Valves and Accessories

The Contractor shall furnish all valves and other accessories for pipe installation as specified herein and as shown on the drawing and in the Bill of Quantities. All valves and other accessories shall be of the size specified and, as far as possible; all valves of the same type shall be of one manufacturer.

All valves and accessories shall have cast on the body the name of the manufacturer, working pressure, diameter, and direction of flow.

All flanges for pipes, fittings, valves shall comply with DIN 28604 for PN 16.

Stuffing boxes shall be of the "O" ring or packing type, unless otherwise specified.

The Supplier shall submit shop drawings to the Engineer for approval. Shop drawings shall include:

- lists and schedules of materials
- details of joints (and adaptors if necessary)
- Names of manufacturers, size, details, materials and thickness of all items.

All valves and accessories shall be designed for a working pressure of not less than PN16, unless otherwise specified. The Supplier shall submit a certificate from the manufacturer certifying that each valve meets the requirements of the specifications.

Valves shall be equipped with hand lever, hand wheel, or as specified. Valve ends shall be flanged, Screws and rubber ring gaskets shall be provided to joint to the valve with the piping.

9.39.5.Gate Valves

Gate valves are to be provided according to DIN 3352 for water up to 40 degrees Celsius with fixed, non-rising hand-wheel. The body shall be of cast iron GG-25 or ductile iron.

9.39.6.Butterfly Valves

Each valve shall consist, essentially, of a cast-iron or ductile iron body with a rubber seat, a disc, a valve shaft, and an operating mechanism. It shall conform in all respects to DIN 3354, part 2.

9.39.7. Air Release Valves

Air release valves shall have high strength cast or ductile iron bodies. The valves shall contain an integral shut-off valve for use during maintenance.

All moving parts shall be of stainless steel.

Complete unit with gate valve connection of the single and double type shall be provided as shown on the drawings and wherever necessary.

9.39.8. Safety Valve

The safety valve shall be a spring-loaded type with adjustable pressure range as shown in the Bill of Quantity. The safety valve shall be manual releasable by a lever arm.

9.39.9. Non-Return Valves

Non-return device with silent action tight sealing designed for a pressure of PN 16 for streamlined flow and minimum head loss.

9.39.10. Float Outlet Valve

Float-operated level control valve, angle-type body for water reservoirs. Closing with rising water level and opening with sinking water level. Balanced valve piston shall ensure minimum operating forces. A long piston guiding shall prevent canting. Closing action shall be shock-free.

9.39.11. Dismantling Piece

The dismantling piece shall be rigid type and provided with steel middle ring, steel followers, gas and necessary bolts and nuts of galvanized steel. They have to be installed in their medium length.

9.39.12. Pipe Compensator

The pipe compensator shall be of rubber type and provided with flange as specified in the Bill of Quantity. The pipe compensator shall contain anchor sturdy of strength adequate to hold the pipe together under a pull equal to the longitudinal strength of the pipe.

9.39.13. Wall Duct

The wall duct shall be of steel body and provided with rubber/solid gasket, bolt and nuts, and loosed flange according to working pressure as specified in the Bill of Quantity. The length of wall duct shall be suitable of the concrete wall width specified in the Bill of Quantities.

The connecting pipe to be inserted in the wall duct shall have four degrees deflection without any leaks.

9.40. Filter Plant

9.40.1. Scope of Works

The following main components are to be provided and assembled: -

- Pump Sets (two duty, one standby)
- Air Blower Sets (One standby)
- Piping with Accessories
- Measuring Devices

9.40.2. Backwash Pump Set

The pumps shall be horizontal centrifugal volute casing pump type

coupled with appropriately rated electrical motor and will be installed in a pump house.

The total efficiency of pump and motor shall be as high as possible. Operation of the pumps shall be 2 duty pump and 1 stand-by. The pumps shall be capable of raising water from the outlet of the clear water tanks to the elevated backwash water tank.

9.40.3. Scope of Works

The following components are to be provided and assembled to one unit:

Each pump; Single stage horizontal volute casing centrifugal pump rated 48m³/hr against a head of 45m coupled with using HRC couplings to an 11kW, 3ph, 1450rpm squirrel cagemotor, all mounted on a common prefabricated steel baseplate.

Motor characteristics:

Overheating protection: by over current and phase

failure strip Cooling: surface

Insulation class: F (motor dimensioning for B)

Protection class: minimum, IP 55

Power supply: 415 V, AC, 50 Hz, 3-

phase Starting: Star/delta

Phasing 3

Rev per minute

1450 Particular

Requirements

Pump and motor shall be mounted on a common rigid base frame. The shafts shall be

coupled by HRC coupling, which must be easily replaceable.

9.40.4. Air Blower Set

The scope of supply shall comprise: 2 scour air blowers with motors, air inlet filters and silencers; piping, no return valves, butterfly type shut-off valves, safety unloaded and drain valves.

Type

Rotary piston air blower set, directly coupled via an elastic coupling with electric motor, both mounted on a common rigid base frame.

Motor characteristics:

The blower shall be completely equipped with an automatic unloading device for starting, with dead weight pressure relief valve, pressure gauge, etc.

The air inlet pipes shall be fed through the machine hall wall and the inlet filters shall be mounted on the exterior side of the wall.

The blower shall be equipped with noise absorbing housings. Both, delivery pipes between the rubber compensators of the blower and the main header to the filter, including the manually operated butterfly valves and an automatic drain valve for draining of condensed water shall be furnished. The piping shall be of the steel-flanged type.

Piping and Accessories

The scope of works includes all pipes, fittings, valves, connecting and fixing materials with installation at the filter plant including connection piping to the pump house and the piping in the pump house itself.

The connecting material (screws, nuts and gaskets) as well as the fixing material (supports, clamps, and suspenders) for the equipment which is to be installed in or on the pipes (e.g. valves, dismantling pieces, measurement and control devices) are to be included. Furthermore, the pressure test, the flushing and the disinfection of the pipes is to be quoted with the relevant items of the B.O.Q. (Bill of Quantities).

Further all parts to be embedded in concrete shall be located according to the drawings or according to the instructions by the Engineer at site with written approval.

Design Requirements

The maximum internal pressure of the filter plant piping is the test pressure. The design pressure shall be PN 16. All parts shall be made of cement lined epoxy coated steel.

9.40.5. Measuring Devices

Flow meters shall be provided for each discharge pipe of the backwash pumps to the Engineer's satisfaction and approval. Hour meters of each pump and air blower shall be provided.

9.41. Chemical Treatment Plant

The chemical treatment consists of three plants to store, prepare and feed the chemicals:

- Aluminium sulphate for coagulation
- Soda ash (sodium carbonate) for pH correction
- Calcium hydrochlorite for disinfection

The equipment for the chemical treatment will be arranged in four rooms as follows:

9.41.1. Scope of Supply

The following components are to be provided and to be assembled:

- Internal water supply
- Air supply
- Aluminium Sulphate Dosing
- Soda Ash Dosing
- Calcium Hypochloride Dosing
- Control Measuring and Safety Devices
- Piping with Accessories

9.41.2. Weighing Devices

The chemical house shall be provided with one weighing device with a capacity of 100 kg with division to enable accurate control of coagulant solutions concentration.

Pipes and Fittings

The chemical house shall be provided with all necessary connecting pipes between tanks, pumps, and injection point. The pipes shall be fitted with all

necessary fittings, erection pieces, valves etc. All piping shall be of the poly-vinyl chloride pipes. All valves shall be made of either poly-vinyl chloride or rubber-lined grey cast iron.

The feeding pipes shall be installed as DN 16; the maximum flow velocity shall be 0.21 m/sec.

9.41.3. Soda Ash Dosing

A complete soda ash feed system shall be provided with efficient modern devices for measuring and adding the required chemicals to the water treatment.

All feeding chemical equipment shall be capable of manual adjustment according to the variations in the raw water quality and/or flow indicated by the flow meter fitted to the raw water pipe.

The soda ash is delivered as powder or granulates in 50 kg bags. Its active ingredient of Na₂CO₃ is 99 to 100%.

The solution will be prepared batchwise in two tanks of a net volume of 560.1

The average dosing rate will be 8 g/ m³ and the maximum dosing rate will be 16 g/ m³ (related to the delivered chemicals).

This results in 4.8% maximum strength of the solution. That means 26.81 kg soda ash are to be mixed with water to 560.1 solution.

Based on the average feeding rate of 8 g/ m³, the volume of 560.1 solution has to contain 13.40 kg soda ash.

An alarm "Trunk Empty" will be triggered by an electrical signaller if the level of the solution drops to a minimum.

The scope of supply includes in general:

- Soda dissolving tanks
- 3 soda metering pumps (one as stand by)
- Pipes and fittings as

necessary Soda Dissolving

Tanks

The Contractor shall furnish four soda dissolving tanks. Each shall have a capacity of net 2000 lts.

Soda Metering Pumps

Three metering pumps (one as stand-by unit) are to be installed, each capable of handling a capacity of Q = 2000 l/h.

To facilitate the maintenance and to minimize the needed spare parts, the same type of metering pump will be installed as described before.

9.41.4. Piping with Accessories Scope of Works

The scope of works includes all pipes, fittings, valves, connecting and fitting materials with installation in the pump station including connecting piping to the distribution system.

The connecting material (screws, nuts, and gaskets) as well as the fixing material (supports, clamps, and suspenders) for the equipment, which is to be installed in or on the pipes (e.g. valves, dismantling pieces, measurement, and control devices) are to be included. Furthermore* the pressure test, the flushing and the disinfection of the pipes has to be quoted with the relevant items of the B.O.Q (Bill of Quantities).

Further all parts to be embedded in concrete shall be placed according to the drawings or as instructed by the Engineer at site with written approval.

Design Requirements

The maximum internal pressure of the plant piping is the test pressure. The design pressure shall be PN 16. All parts shall be made of steel.

9.41.5. Measuring Devices

Water Level Measurement and the pump controls.

Sets of electrodes shall be installed inside the pump sump (clear water tank) for indication of water levels (LOW AND HIGH) and the same electrodes to serve as dry run protectors. The indicator lamps shall be provided on the control panels.

9.41.6. Calcium hypo-chlorite Dosing

A complete calcium hypo-chlorite feed system shall be provided with efficient modern devices for measuring and adding the required chemicals to the water treatment.

All feeding chemical equipment shall be capable of manual adjustment according to the variations in the raw water quality and/or flow indicated by the flow meter fitted to the raw water pipe.

The calcium hypo-chloride is delivered as powder or granulates in 50 kg drums. Its active ingredient as free chlorine is approximately 60% by weight. The maximum feeding rate at the inflow of the clear water reservoir shall be 3 g/m³ (600 g/hr) chlorine (equivalent to 5 g/m³ calcium hypo-chloride) for post chlorination.

For the maximum demand during operation of chlorination with a summarized feeding rate of 3 g/m³ (calcium hypo-chloride) and a plant capacity of Q = 200 m³/hr. the solution is to be prepared in one solution tank, whose net volume is 186 l, using 13.90 kg calcium hypo-chloride: the strength of the solution is 7.47%, When a lower demand is to be expected, e.g. 1.5 g/m³ the strength can be reduced to 2.51 g/m³ for 186 l solution (0.45% strength).

To prepare the solution, the selected quantity of calcium hypo-chloride will be filled in the tank. Later, the solution will be completed by filling water to 186 l total volume. Finally, it will be mixed manually by a mechanically operated stirrer.

Due to the insoluble particles of the calcium hypo-chloride, a swimming skimmer, which is flexibly connected to the solution outlet should, be used to abstract this from the surface. An additional outlet is to be used periodically to desludge the bottom of the tank.

The solution is fed by gravity via hand operated Valve to one of two dilution tanks located below the solution tank. Each dilution tank has a net volume of 560 l. The solution of the upper tank is to be diluted in the ratio

1:2 by completing 280 l water and mixing by a mechanically operated stirrer to the approval of the Engineer.

The scope of supply includes in general:

- i) Calcium hypo chloride solution tank net capacity 186 l,

with handoperated stirrer.

ii) Calcium hypo chloride dilution tanks net capacity 560 l.
With handoperated stirrer.

iii) Calcium hypo chloride metering pumps (one as
stand-by).Pipes and Fittings

These will be similar to the ones for soda ash dosing.

9.42. Measurements and payments

a) Electromechanical
equipmentUnit: nr

Measurement of electromechanical works shall be measured in number of each
equipmentdelivered on site. 60% of the payment shall be paid on delivery of the
complete set of equipment to site and submission of the test certificate from the
manufacturer to the Employer, 40% on installing, testing and commissioning.

The rate shall include for the rate of complying with the requirements of Section 11
of this specification and fittings, accessories, piping, connection, earthing,
installation and testingto the satisfaction of the Engineer.

b) Security lighting

		Unit
i)	Lanterns	Nr
ii)	Street lighting columns	Nr
iii)	MCBS	Nr
iv)	Cables	m
v)	Hatari warning tiles	Nr
vi)	Cable route markers	Nr
vii)	PVC service ducts	Nr
viii)	Photocell light controls	m

Measurement of security/street lighting items listed above shall be measured in
numberssupplied or linear metres as appropriate. The rate shall include costs for
supply material,fittings and accessories for each unit, fabricating, installing and
preparation of shop drawings to the approval of the Engineer.

10. TREATMENT WORKS SPECIFICATION

10.2. General Provisions

10.2.1. Extent of Work

Work under this section of the Specification comprises the supply, delivery to Site, and construction and erection of the complete treatment works and pump stations, as described in the Specification, including all materials, labour, transport, implements, and other items necessary for the manufacture and installation of the plant and equipment and the construction of the treatment works and pump stations including, but not limited to, testing at the manufacturer's works, protection of the plant and equipment against corrosion, packing and delivery to Site, erection of the plant and provision of all equipment and materials required for the testing, commissioning and supervision of operation of the Works upon completion, as well as training of the Employer's personnel in its operation.

10.2.2. Limits of Construction and Supply and Installation

The expression "Limits of Construction and Supply and Installation" as used in this Sub-section and elsewhere in this Specification, shall mean the limits of the obligations of the Contractor under the Specification in respect of:

the supply of all materials and construction of the treatment, hydraulic and associated structures;

the supply of the plant and equipment by the Contractor as specified herein;

installation of the plant and equipment at Site by the Contractor, including all necessary mechanical or electrical work, as required under the Contract.

10.2.3. Works within Limits of Construction and Supply and Installation

The following shall be included within the Limits of Construction and Supply consisting of the following units.

a) Water Concrete Gravity Intake Weir

the concrete gravity intake weir is made entirely of concrete as per the drawings and will have

(i) ungated overflow spillway with stilling basin (ii) intake tower upstream of weir and grouting foundation treatment as per the specifications for grouting.

The foundation treatment shall allow for (i) exploratory drilling and (ii) grouting to 10-15m depth using primary, secondary tertiary grout holes as exploratory drilling will confirm on site., but the extent is not expected to exceed the provision given in the BOQ.

(b) Water Treatment Works

The treatment, hydraulic and associated structures including:

Chemical Dosing and Mixing Tank (including flow measurement and chemical dosing), flocculation channel, sedimentation tanks

Filters, treated water detention tank, backwash water tank, chemical store and dosing building.

Access roads, car parks, earthworks, drainage works other related site works.

Complete process and related equipment, within and between process unit structures, such as influent control, sedimentation tanks and filters.

Pipework within and between process unit structures, such as tubing and piping of any description and materials, with all fittings, penstocks and valves thereto, external coatings and internal linings of pipework.

Mechanical and other appliances for weighing, proportioning, dissolving and distributing chemical reagents and preparing chlorine solution, including strainers, stirrers, mixers, dispensers, meters, pipework, etc., and pipes for applying chemical reagents and chlorine solutions within and between process unit structures.

Mechanical and other equipment such as trolleys, hoists for handling, storing and lifting of chemicals.

Equipment, including motors, pumps, compressors, blowers, valves and fittings for wash and scour systems, and other systems.

Laboratory equipment and reagents.

Regulators, instruments, indicators, gauge plates, flanges, connectors, gaskets, bolts, units, washers, jointing material, materials for building in, jointing and securing, nameplates, identification tags; cable splices, glands, boxes, junctions and ancillary material; fasteners, clips, stands, trays, hangers, and all other auxiliary materials of any description.

Filter bed media.

b) Pump Stations

Supply and installation of 2 no. pump units and related auxiliary equipment including, but not limited to pumps, electric motors and starters, valves and fittings, cranes, switchboards, complete electric power control and lighting installation, cables and accessories.

All negotiations and payment for the permanent power supplies to be provided by the Kenya Power and Lighting Co. Ltd. and including power distribution throughout the Site.

10.2.4. Plant and Equipment Details

The Contractor shall fill in the Schedule of Particulars attached to the Bill of Quantities and submit same prior to Contract award if required to do so by the Engineer. After approval by the Engineer the particulars so given shall not be departed from without his written consent, provided that any omission from the particulars given shall not relieve the Contractor of any of his obligations under the Contract.

10.2.5. Modifications and Alternatives to Basic Design

The Contractor may propose modifications to the treatment processes which in his opinion are improvements to the Basic Design.

Modifications offered and accepted shall not fall short in any respect of first class installations and of the requirements of the Basic Design, and all details of finish and completion herein specified shall be deemed to be included in the modifications.

10.2.6. Standards

For the sake of brevity, in most cases one single standard has been mentioned in the various sub-sections of the Specification.

However, any other internationally accepted standards, which ensure an equal or higher quality than that mentioned will also be accepted. Only the latest editions of such standards shall apply.

10.2.7. Calibration of Gauges, etc.

The scales and dials of all gauges, indicators and similar instruments shall be calibrated in metric units of measurement as follows:

- Pressure instruments - metres head of water
- Level - metres and tenths of meters
- Flow (integrated) - cubic metres
- Flow rate - litres/second

10.2.8. Inspection and Testing during Manufacture

No item of electrical or mechanical plant and equipment or any portion or part thereof shall be shipped or transported until all tests, analyses, and shop inspections of materials and equipment have been completed and accepted, unless certified reports or other evidence of the plant's compliance with the requirements of the Specification have been accepted by the Engineer, or unless inspection has been waived by him.

Tests are to be carried out on all plant as provided for in the Specification and otherwise in accordance with the latest Standard Specification where appropriate to the plant concerned. The Contractor shall carry out such tests and provide the Engineer with duly certified records in triplicate of the results obtained.

The Contractor shall give the Engineer reasonable notice in writing of the date on and the place at which any plant will be ready for testing as provided in the Contract and, unless the Engineer shall attend at the place so named within 10 days of the date which the Contractor has stated in his notice, the Contractor may proceed with the tests, which shall be deemed to have been made in the Engineer's presence. The Engineer shall give the Contractor 24 hours' notice in writing of his intention to attend the tests.

All measuring and testing instruments, indicators and other apparatus provided by the Contractor shall be calibrated under guarantee of an approved testing laboratory, or

otherwise to the satisfaction of the Engineer.

The Contractor shall provide all labour, lubricants and stores required for the purpose of these tests. The costs of carrying out all tests shall be included in the rates tendered.

10.2.9. Packing, Marking and Delivery

After approval by the Engineer and prior to dispatch from the manufacturer's works, all electrical and mechanical plant and equipment shall be thoroughly protected against corrosion and incidental damage, including the effects of vermin, strong sunlight, rain, high temperature and humid and salty atmosphere or sea spray.

The plant shall be packed to withstand rough handling in transit, and packages shall be suitable for export to and storage in the tropics, including possible delays on exposed quaysides. The Contractor shall be held responsible for the plant being packed so that it reaches its destination intact and undamaged. The Contractor shall provide, and include in the Contract Price, the cost of all necessary packing cases and crates. All crates and packages shall be correctly and adequately marked as follows:

- Name of the Project
- Contract Number
- Designation of Plant
- Item Number.

The Contractor shall keep the Engineer fully informed of the status of deliveries.

The Contractor shall be responsible for the delivery of the plant to Site.

10.2.10. Installation and Erection General

The Contractor shall carry out the complete installation of the plant, including all skilled and unskilled labour, material, transportation, supplies, Contractor's equipment, and appurtenances necessary for the complete and satisfactory erection of the plant.

Work Programme

The Contractor shall submit to the Engineer a work programme for the erection of the plant, within one month from the date of the Engineer's request for such programme. The work programme shall show the order in which the various plant elements will be installed, the Contractor's equipment to be used for installation, and a list of the skilled, semi-skilled and unskilled workers to be employed, and their respective arrival dates on Site.

Erectors

The Contractor's staff shall include at least one approved skilled installation supervisor for the installation of all plant and equipment under the Contract, and sufficient skilled, semi-skilled and unskilled workers to ensure completion of the Contract within the time required. The Contractor's installation staff shall arrive at Site on or before the respective dates set out in the approved programme of work.

Contractor's Equipment, Materials and Appurtenances

The Contractor shall have available on Site sufficient suitable equipment and machinery as well as all other materials and appurtenances required by him of ample capacity to ensure the proper installation of the plant and equipment.

Workmanship

The plant shall be erected and installed in a neat and workmanlike manner on the foundations and at the locations and elevations shown on the approved working drawings. Unless otherwise directed by the Engineer, the Contractor shall adhere strictly to the aforesaid drawings and no departures therefrom will be permitted. All plant shall be correctly aligned, leveled and adjusted for satisfactory operation, and shall be installed so that the proper and necessary connections can be made readily between the various units and the piping and equipment installed under the Contract.

Building-in

Before commencing any installation works the Contractor shall check the dimensions of structures where the various items of the plant and equipment are to be installed, and shall bring any discrepancy from the required position, lines or dimensions to the notice of the Engineer.

The Contractor shall also propose, for the approval of a Resident Engineer, any necessary corrections. The Contractor shall and plug in the holes prepared by him and provide all clips, plugs, screws, nails, sleeves, etc. Required for fixing small bore tubing and piping. The Contractor shall align all pipework, equipment, holding-down bolts, etc.

Commissioning

As soon as the Engineer is satisfied that the installation of the plant and equipment has been completed, the Contractor shall have satisfied himself that the plant and equipment are in good working order and the Engineer is satisfied that the associated civil engineering works have been substantially completed to an extent permitting the proper operation of the treatment units, the Contractor shall himself operate the treatment works (including the pumpstations) during the period of time specified below (hereinafter referred to as the commissioning period). The cost of commissioning shall be borne by the Contractor.

Commissioning shall commence at such date, determined by the Engineer, as the Contractor has successfully put the entire treatment works and both pump stations into operation; however, the Engineer will not delay the commencement of commissioning on account of minor deficiencies in the Works which do not materially affect their operation. The commissioning period shall terminate after the Works have been satisfactorily and continuously run by the Contractor (as certified by the Engineer) for one week.

During the commissioning period the Contractor shall supply all fuels, chemicals, electricity, etc. required for the operation of the Works at his own expense.

Site Tests - Taking - Over

After the termination of the commissioning period as defined in Subsection above, the Contractor shall prove by site tests that the duties specified in the Schedule of Particulars and Guarantees are being performed continuously by each element of the Works for a period of at least 24 hours under the control of the Contractor's staff and the supervision of the Engineer.

All measuring instruments, indicators, and all other apparatus required for site tests shall be provided by the Contractor at his own cost and shall be included in the prices for the construction of the Works. All measuring instruments shall be attested as having been calibrated by an approved testing institute or otherwise to the satisfaction of the Engineer.

Any deficiencies or deviations from the guaranteed performance of the Works disclosed by the site tests shall be corrected by the Contractor, and site tests repeated as necessary until proper performance of the works-specified above, has been achieved to the satisfaction of the Engineer.

After the site tests have been satisfactorily completed, as certified by the Engineer, and provided that the Contractor has discharged his obligations under the Contract, the Contractor may apply for the Completion Certificate.

The Engineer shall not delay the issue of any Completion Certificate contemplated by this Sub-section on account of minor deficiencies of materials or defects of the Works which do not materially affect the commercial use thereof, provided that the Contractor shall undertake to make good same within 30 days of the issue of the Completion Certificate.

Training of Employer's Personnel

The Contractor shall train personnel assigned by the Employer in accordance with the training programme included by him with his tender and approved by the Engineer. Training of the Employer's personnel shall be aimed at achieving optimum operation of the Works, including minimizing use of chemicals, loss of water and staff required. This shall include training staff in all processes involved, water quality routine tests, control of chemicals, routine and periodic maintenance of every piece of equipment, and in all other subjects as may be required for satisfactory operation of the Works. The Contractor shall train the Employer's staff so that, at the conclusion of the commissioning period and upon the issue by the Engineer of the Completion Certificate, the staff can be entrusted with the operation and maintenance of the Works.

The Contractor shall continue with the training of the Employer's personnel for a

period of four weeks after the date of the Completion Certificate.

Instruction Manuals, "As-constructed" Drawings ~ General

The Contractor's obligations include, as a condition precedent to applying for a Completion Certificate, the provision of 3 complete sets of instruction manuals and 3 sets of "as-constructed" drawings to be submitted within four weeks after the Contractor has received the Completion Certificate.

These manuals and drawings shall form part of the Operating and Maintenance manual referred to in the Specification.

Instruction Manuals

The instruction manuals shall cover the commissioning, testing, operation and maintenance of the entire Works. The greatest importance is attached to completeness and clarity of presentation.

It is emphasized that a collection of standard pamphlets of a general nature unaccompanied by drawings and descriptive matter relating to the Works as constructed, will not be acceptable. In particular, information supplied by subcontractors and manufacturers employed by the Contractor shall be coordinated into a comprehensive manual. Cross referencing of descriptive matter, drawings and spare part lists must be complete. The manuals shall be in English.

The instruction manuals shall describe the installation as a whole and shall give a step-by-step procedure for any operation likely to be carried out daily, weekly, monthly and at longer intervals to ensure trouble-free operation. Where applicable, fault location charts shall be included to facilitate tracing the cause of malfunction or breakdown.

A separate section of the manual shall be devoted to each size and type of equipment and to each system of the Works.

It shall contain a detailed description of its construction and operation and include all relevant pamphlets, together with a list of parts with procedure for ordering spares. Electrical equipment shall be described in operation step-by-step giving the complete sequence of operation.

As-constructed Drawings

The "as-constructed" drawings shall be submitted within four-weeks after the Contractor has received the Completion Certificate. They shall cover the Works as completed on Site, incorporating all modifications carried out during manufacture or after testing at the Contractor's or sub-contractor's and manufacturer's works and all modifications carried out in the course of the installation and commissioning and testing of the Works. These drawings may be produced by modifying the drawings produced for manufacture and the working drawings.

11. Plant and Equipment General

11.2. Description of Works

11.2.1. Treatment Works

The purpose of water treatment is to convert water taken from Masinga Dam located along Kitui-Embu road the ("raw water"), into a potable water suitable for domestic use. Most important is the removal of pathogenic organisms or other substances causing health hazards. Other substances need to be removed or considerably reduced, including suspended matter causing turbidity, iron and manganese compounds.

The primary factors to be considered in the selection of the treatment process are:

- Treated water specifications
- Raw water quality and its possible variations
- Local constraints (such as availability of major equipment, construction materials and water treatment chemicals)
- On the basis of the above considerations and of field and laboratory investigations, the treatment works shall consist of:
- Chemical coagulation, by dosage of alum, and of alkalis (such as soda ash) or pH control
- Pre-chlorination, to avoid algal or bacterial growth within the subsequent treatment processes;
- Chemically-aided settling in horizontal flow sedimentation tanks, in which flocculation takes place at the base of the cone and clear water is decanted from the top surface. Sludge is removed both from the bottom of the tank
- Filtration through rapid gravity filters cleaned with an air/water backwash system;
- Final disinfection by chlorination, utilising calcium hypochlorite or other chlorine based compounds.

The treatment plant is structured as shown in the table below:

Treatment Process	Treatment Unit Type	No.	Surface loading (m ³ /m ² /d)	Surface Area/Unit (m ²)	Total Design Flow (m ³ /d)
Flocculation	Tank with electrically driven paddle mixers	2			9,000
Sedimentation	Horizontal flow tanks	2			9,000
Filtration	Downward vertical flow rapid gravity filters with air/water backwash. Filter media to be 800 mm sand (0.8 to 1.2 mm grain size) on 300 mm gravel bed. Filter Bed Cleaning Water Air	4			9,000
Maximum Losses Sedimentation Constant sludge bleed (0.5 l/s) per unit Bottom Desludge (20m ³ /unit/day) Filtration Backwash water (8min /unit/day)					
Minimum output					9,000

Weir shall be provided with a float operated instrument for measurement of the rate of flow with local indication. The flow rate indicator shall be mounted in a weatherproof

metal box with hinged door and latch at the inflow control valve and shall be supplied with a 150 mm diameter dial gauge with uniformly graduated scale from zero to maximum liters/second.

11.2.2. Mixing Tank

A mixing chamber unit shall be constructed to the dimensions shown in the drawings. The mixed water shall be discharged through a pipeline to the Coagulation chamber. The pipework arrangement shall allow the raw water by-passed directly to the weir when required.

All discharge and isolating valves shall be of the rubber-seated butterfly type.

11.2.3. Coagulation Chamber

A channel with electrically driven paddles designed to specifications and installed in the chamber shall ensure uniform dispersion of the coagulant in the raw water entering the treatment works.

11.3. Sedimentation Tank

The sedimentation tanks shall be of the horizontal flow, sloping bottom type, two in number, all jointly capable of passing a total design flow of 72,000 m³/d.

At this design rate of flow, the rise rate, when calculated on net surface area, shall not exceed 1.75 m/hr.

The tanks shall be capable of operating at a rated capacity of 2.0 m/hr while one is shut down for maintenance purposes.

Each tank shall be equipped with a sludge concentrator, complete with a draw-off assembly to provide for regulated "bleed-off" of the sludge.

After passing the sludge blanket, the water will be drawn-off by decanting troughs. The troughs shall have notched or drilled sides to provide accurate adjustment for uniform draw-off.

The effluent from the tanks shall be completely stable and no after precipitation shall take place. A pipe work for an overflow shall be provided in the inlet water distribution channel.

All pipes, penstocks, valves, extension spindles headstocks, etc. shall be provided to make the tanks complete in every respect for the distribution and collection of water and the removal of sludge.

The amount of water lost with the sludge draw-off in the horizontal sedimentation tanks shall in no case exceed five percent of the total treated water produced.

11.4. Filters and Appurtenances

11.4.1. Filters General

Filters shall be of the rapid gravity downward flow type, constructed in concrete as shown on the drawings. The Contractor shall supply and install all equipment and pipework required for the six filter units, which shall jointly be capable of filtering the total design flow of 72,000 m³/d at a rate not exceeding 5.0 m/hr at normal filtration or 6.0 m/hr when one filter unit is shut down for washing or maintenance purposes.

The Contractor shall guarantee that the filtered water turbidity shall never exceed 1 JTU (Jackson Turbidity Unit). The average washwater consumption shall not exceed 5 percent.

The water leaving the filters shall possess the following Characteristics

- Turbidity less than 5 JTU
- Color less than 5 units (platinum-cobalt scale) unobjectionable
- Odour unobjectionable
- Taste unobjectionable

Filtered water shall be sampled for measure of compliance at any point between the filter outlet valves and the points of application of soda ash for pH correction and calcium hypochlorite for disinfection. The measure of compliance with the guaranteed limit of water consumption in filter washing, as inserted by the Contractor in the "Schedule of Guarantees", shall be ascertained on the basis of the average consumption of water over a

period of one week. The inflow shall be divided equally between the working filters, and shall be shut off at each filter by an isolating valve or penstock. The filtered water from each filter will flow into a common channel or pipe system.

The filters shall be constant flow/rising head type, the increase in filter head loss during a filter run being compensated by the automatic opening of the filter outlet control valve.

The outlet control valve shall be of a butterfly valve type drop-tight construction suitable for mechanical actuation. The outlet control valve shall be actuated by special gear for operating in conjunction with a corrosion resistant float device.

All pipework and fittings embedded in the concrete floor of the filters shall be made of corrosion-resisting materials. The cleaning of the filter beds shall be accomplished by means of air scouring, followed by a water backwash.

The backwash shall be provided by a piped supply, and the waste water shall discharge into two side channels and thence to a waste water drain located under the settled water inlet channel.

All pipe work, fittings and valves necessary for the operation of the filters and for the filter backwash system shall be provided. All valves shall be of the rubber-seated butterfly type.

11.4.2. Filter Base

The filter base shall consist of a platform, laid above the filter floor. The platform shall be made of pre-cast concrete plates, supported and fixed on concrete pillars.

Each plate shall have evenly spaced non-metallic threaded couplings cast in for filter nozzle installation. Nozzles shall be so shaped and proportioned that they will convey filtered water downwards to the filter outlets and, during backwash, compressed air and backwash water upward into the filter bed. The spacing of the nozzles shall be such as to provide an even collection of filtered water and an even distribution of air and backwash water. The size of nozzles shall be designed by the supplier of the filter base to pass the maximum rated daily flow per filter: backwash at a rise rate of approx. 36 m/h, and air at a rate of 60 cu m/sqm/hour.

The filter base shall be designed and constructed to withstand both normal flow and backwash flow loading conditions.

11.4.3. Filter Media

Filter media consisting of gravel and sand shall be furnished by the Contractor and placed in each of the six filters.

The Contractor shall furnish an additional 25 cu m. of sand filter media, in 50 kg heavy-duty moisture-proof plastic sacks for storage, as directed by the Engineer.

The Contractor may propose single or multi-media, as required, for the filter base arrangement proposed by himself. In either case the Contractor shall guarantee that each filter unit shall deliver not less than the specified daily flow per day at the required filtration rate offlow and that the filters shall not require washing more than once every 24 hours of operation.

11.4.4. Air Scour Blowers

Two electrically driven blowers shall be provided to supply the complete system of air for scouring of filters, each unit delivering the requirement for scouring one filter unit. The blowers shall supply air at the related pressure and quantity without employing any pressure reducing valve and air flow indicator.

A pressure gauge shall be provided and installed in the delivery end of the air main.

The installation shall be provided with all fittings, valves, pipes and controls necessary to render the air scour system complete in all respects.

11.4.5. Washwater Supply System

Water needed for filter washing will be provided from a washwater tank of 200 cubic meters capacity on 15m tower.

The washwater tank, constructed with a central division wall, will be complete with all necessary inlet, outlet, overflow and washout pipework and valves, access hatch, external and internal ladders, air vents, float operated level indicator, chambers and all other associated works.

Head available at the backwash inlet to the filters shall be in the range 7.0 to 11.0 m of water or to lower pressures as agreed with the Engineer. The Contractor shall state the duration of each filter washing, rate of flow and head required. All piping, fittings and valves on the backwash

11.4.6. Washwater Control System

A manually controlled washwater flow system shall be provided. It shall consist of a "star" regulating valve installed in the backwash inlet main from the wash water tank and located in the filter gallery upstream of the individual backwash valves to each filter.

a) Fill washwater tank.

b) Close regulating valve.

Open backwash inlet valve to filter to be backwashed. Close filter inlet valve and drain filter.

Open regulating valve slowly and time "be" till water level from top of sand bed to backwash overflow channel.

Repeat until rise rate is correct (approx. 600 mm/minute). Remove regulating valve handwheel.

11.4.7. Washwater Tank Level Control.

The Contractor shall supply and install high and low level electrodes for backwash pump automatic stop/start control. The pump shall be stopped when the water reaches top water level, and be started when the water level has dropped to 1 m below top water level.

11.5. Chemical storage preparation dosing and testing equipment

11.5.1. Chemical Equipment – General

Equipment shall be provided for the handling and storage of the dry chemicals, solution preparation and storage, chemical solution dosing and for provision of sampling points throughout the treatment works and laboratory equipment for routine testing of the raw, partially treated and treated waters.

The chemicals to be used are:-

Aluminum Sulphate Alum" - sedimentation process

Soda Ash pH correction at the treatment works inlet

Calcium hypochlorite (HTH) pre-chlorination at the filter inlet channel and post-chlorination at the treated water reservoir

11.5.2. Supply of Chemicals

The Contractor shall supply sufficient chemicals for the testing and commissioning of the treatment works and, in addition, shall supply, and place in the storage to be constructed, sufficient chemicals for the running of the treatment works at the design rate of 6,000 m³/d for a period of 2 months. The chemicals to be provided and stored are:

- | | | |
|-----|---|-------------------|
| (a) | Aluminium sulphate | 1000 x 50 kg bags |
| (b) | Soda Ash | 500 x 50kg bags |
| (c) | Calcium hypochlorite (70% available chlorine) | 200 x 45kg tins |

11.5.3. Chemical Storage

Storage shall be constructed of sufficient capacity for the storage of 1

months Aluminium sulphate 1000 x 50 kg bags

The storage area shall be:

Net area 54m²

Gross area 80m²

Soda Ash 500 x 50kg

bags The storage area shall

be:

Net area 54m²

Gross area 80m²

Calcium hypochlorite 200 x 50kg bags

The storage area shall be:

Net area 40m²

Gross area 50m²

The storage rooms shall be separate from each other and under no circumstances

shall different chemicals be stored in one room.

Floors: reinforced concrete with quarry tile surface finish to be raised 200mm in 1 above passageway floors.

Walls: white gloss paint.

Windows: fixed timber louvered windows installed at high level.

Doors: steel panel double doors with bottom panel composed of fixed louvres. All doors open outwards from storage rooms.

Door hinges, locks and latches: doors to be capable of folding back 180° from closed position against outside walls (provide hook latches for securing in open positions). Door locks to enable instant "panic" opening of both doors from the inside even when locked from the outside.

Trolleys:

No. four-wheeled manually pushed trolley capable of transporting a load of 200 kg. No. two-wheeled trolleys, each with a load capacity of 100 kg.

g. Step ladders:

3 No. 2 m high aluminium step ladders

h. Weighing platform:

1 No. heavy duty weighing platform suitable - weighing up to 250 kg 100 gram meso solution preparation and dosing tanks of the following capacities and sizes shall be constructed

- (a) Aluminium Sulphate solution 2 No.
Capacity 7,000 litres net.
Size 2 m x 2 m x 1.75 m
- (b) Soda Ash solution: 2 No.
Capacity 7,000 litres net.
Size 2 m x 2 m x 1.75 m
- (c) Chlorine solution: 2 No.
Capacity 7,000 litres net.
Size 2 m x 2 m x 1.75 m

Full-bore outlet valve with hose connection for 20mm flexible tubing (as PCI or similar and approved - suitable for connection to chemical pumping unit dozer);

80mm diameter plug valve c/w pipe work to discharge to waste-water channel (as Biwater-Ham Maker Cat.no.86 or similar and approved);

Alum tanks only-rock alum perforated rack positioned along inlet side of solution tank made from alum corrosion resistant materials and securely fixed to the tank. The tanks shall be lined with ceramic tiles or GRPs, fittings and pipe work shall be manufactured from materials which are corrosion resistant to the respective chemicals stored in the tanks.

Chemical pumping units dozers manufactured by reputable firm and approved by the Engineer and complete with all necessary valves, fittings, tubing and outlet collection funnels or troughs shall be installed as follows:

- a) Alum tanks 2 No. Chemical pumping units dozers
- b) Soda ash tanks 2 No. Chemical pumping units dozers
- c) Chlorination tanks 2 No. Chemical pumping units dozers

The chemical pump dozer outlet shall be connected by suitable tubing to hard rubber chemical solution pipelines leading to various points of application of the chemicals.

A treated water supply from high level tank shall be provided for connection to each of the chemical solution lines for flushing purposes, suitable isolating valves shall be provided.

A treated water supply from a contained in a waterproof carrying case containing plastic tubes or buffer and KCl solutions. The meter should be scaled from 0-14 pH for easy reading and simple adjustment accuracy of 0.1 pH. The instrument and electrode system shall be provided

(2) Colorimeter-spectrophotometer - transistor-regulated model.

Range 349-650 nm, with 12 selected test tubes 1/2" diameter, 1" test tube adapter, plastic dustcover and directions. For operation of 50-60 Hz, 220 Volt AC, incl. 21amps replacement - 6 Volt with pre-focused base and pigtail leads.

(3) Turbidity meter-Hach CR surface turbidimeter, model 1032 or' equal.

(4) Turbidity meter - Jackson standard complete with one 25 cm tube, one extension tube and 12 standard candles.

(5) Stirrer, multiple, water analysis, 6-unit for alum flocculation; determination; speeds from 10rpm to 100 rpm. The entire battery of stirring rods, or any single stirring rod to be able to be used at one time.

With individual 25 mm wide by 75 mm long stainless steel paddles, adjustable for depth, to be able to be removed from the breakers while the stirrer is in operation without disturbing the other paddles. Stirring speeds shall be controlled by a powerstat and indicated by the centrally located tachometer. Aluminium housing, exposed metal parts, nickel-plated 1000 ml beakers and flocculation illuminator base. 1'01' 220 Volt AC, 50 Hz.

(6) Sets of color coated glass disks, chlorine residual

comparator: For residuals 0.0 to 1.0 ppm

For residuals 0.0 to 2.0 ppm

(7) Water Analyses. Taylor - for determining colour with colour standard 5

slide: Colour: 0, 5, 10, 20, 30, 40, 50, 60, 70

A field test kit for running the following tests:

- Fluoride
- Sulphates
- Alkalinity Total Hardness
- Iron
- Manganese
- Phosphates
- Chlorides

12. DAYWORKS

12.2. Measurement and Payment

Where items of major equipment listed in the schedule of Dayworks are specified by type (e.g. concrete mixer e.t.c.) the power rating of such items of equipment to be provided by the Contractor shall not be lower than the power ratings of such equipment, manufactured within the last two years prior to the date of Tender. Any item of major plant employed upon Dayworks which has a power rating lower than specified shall be paid for at rates lower than those in the schedule of Dayworks. The reduction in the rate payable shall be in proportion to the reduction in power rating below that specified above

APPENDIX A: FURNITURE & EQUIPMENT FOR RESIDENT ENGINEER'S STAFF HOUSES

Item	Item Description	PER HOUSE TYPE I	Total Quantity
	FURNITURE		
A1	Kitchen table (formica top)	1	7
A2	Kitchen chair	2	14
A3	Dining table	1	7
A4	Dining chairs	6	42
A5	Dining chairs with arms	4	28
A6	Writing desk (3 drawer)	2	14
A7	Book shelf	2	14
A8	Settee - 7 Seater	1	7
A9	Settee - 5 Seater	0	0
A10	Easy chairs	5	35
A11	Coffee tables	2	14
A12	Side board	2	14
A13	Beds double 6x5 with inner spring, mattresses & bed cover	2	14
A14	mattresses & bed cover		
A15	Pillows	8	56
A16	Side tables	2	14
A17	Dressing tables with mirrors	2	14
A18	Dressing table stools	2	14
A19	Chest of drawers	4	28
A20	Bedside chairs	2	14
A21	Bathroom cabinet with mirror	1	7
A22	Bathroom stool	1	7
A23	Floor rags	5	35
	EQUIPMENT		
A24	Refrigerator (at least 19 cu.ft.) including a freezecompartent of about 3 cu. Ft. capacity	1	7
A25	Refrigerator (at least 7 cu.ft.) including a freezecompartent	0	0
A26	Electric & gas cooker with 4 burners, a grill and an oven	1	7
A27	Electric cooker 2 elements	0	0
A28	Gas or electric		
A29	Fume hood	2	14
A30	Water filter (hot and cold dispenser)	1	7
A31	Dust bin metal with lid(outdoor type)	1	7
A32	Door mats	4	28
A33	Vacuum cleaner	2	14
A34	Set of 8 piece crockery, cutlery, glass wear	2	14
A3 5	Set of kitchen utensils	2	14
A3 6	Set of pots .pans etc	2	14
A37	Fire extinguisher	2	14
A3 8	Standard lamps	5	35
A3 9	Table lamps	2	14

A40	Toilet tissue holders	1	7
A41	Waste baskets	4	28
A42	Mixer electric (portable)	2	14
A43	Bedside lights	4	28
A44	Wall lights	5	35
A45	Pelmets and runners for the house (set)	1	7

Item	Item Description	PER HOUSE TYPE I	Total Quantity
A46	Curtains for the house (set)	2	14
A47	Bed sheets (for bed 6x5ft)	4	28
A48	Bed sheets (for bed 6x4ft)	4	28
A49	Pillow cases	8	56
A50	Blankets (for bed 6x5 ft)	8	56
A51	Blankets (for bed 6x4ft)	0	0
A52	Towel rails	2	14

APPENDIX B: FURNITURE AND EQUIPMENT FOR R.E'S PERMANENT OFFICE			
NOTE: THE WHOLE OF THIS BILL IS PROVISIONAL			
Item	Description	Unit	Quantity
	1. FURNITURE FOR ENGINEER (for the proposed completed office block: To be used in part during the project for the Resident Engineers office).		
B1	Executive desk 2.2x0.9 m with six lockup drawers	No	5
B2	Desk 2.2x0.9 m with chair and three lockup	No	10
B3	Office tables 2.2 x 0.9m	No	5
B4	Swivel orthopaedic chairs	No	2
B5	Standard chairs	No	30
B6	Typist's desk	No	1
B7	Typist's chair	No	1
B8	Stationery clipboard. 1.2 m\ lockable	No	5
B9	Steel filing cabinet- 4 lockable drawers	No	5
B10	Bookshelf. 3 shelves 1.2 m long (to hold box files) with a sliding glass door	No	5
B11	Conference table with 18 chairs	No	1
B12	Curtains for all office windows	Set	1
	2. ENGINEER'S OFFICE EQUIPMENT (Ownership to revert to the Employer upon completion of contract.)		
B13	Multimedia desktop computer with a 17" flat screen monitor. 1TB Hard Disk. 12GB Ram. Core i7 or greater complete with all accessories (UPS. etc) preloaded with windows 10. OS. MS Office professional (latest), MS project, Adobe Acrobat Pro DC and Auto CAD C3D 2019.	No	5
B14	Laptop PC with word processor. 1TB Hard disk. 12GB Ram. Intel core i7 or more or similar approved, windows 10 OS. MS Office professional (latest), MS project, Adobe Acrobat Pro DC and Auto CAD C3D 2019.	No	3

B15	AO plotter as HP DesignJet 510 1067mm 42" AO CAD Plotter CH337A or similar equivalent with Stand. Capable of producing AO drawings in-house.	No	1
B16	Latest HP (A4) colour Printer with Extra print cartridges and accessories	No	2
B17	Print cartridges for HP (A4) printer above (set) Latest HP (A3) Colour Printer with Extra print cartridges and accessories	No.	30
B18	Latest HP (A3) Colour Printer with Extra print cartridges and accessories	No.	1
B19	Print cartridges for HP (A3) printer above (set)	No.	30
B20	HP Scanjet 7450C scanner or equivalent with up to 2400-dpi resolution 50 sheet automatic feeder. fast SCSI and USB connectivity to PC.	No	1
B21	A3 A4 Photocopier (approved make), with feeder sorting trays	No	1
B22	Rolls of A0 paper	No	20
B23	Reams of A4 photocopying paper	No	60
B24	Reams of A3 photocopying paper	No	30
B25	Electronic scientific calculator. 12 figures		6
B26	Stapling machine Ofrex size 50 or similar with 5000 staples	No	6
B27	Heavy duty punch and spiral binder. IBICO AG or similar approved	No	2

APPENDIX B: FURNITURE AND EQUIPMENT FOR R.E'S PERMANENT OFFICE NOTE: THE WHOLE OF THIS BILL IS PROVISIONAL

Item	Description	Unit	Quantity
B28	Inkjet Plain Paper Fax Machine with 4MB of memory	No	1
B29	Pencil sharpener (desk mounted type)	No	6
B30	Heavy - duty 2 hole paper punch	No	2
B31	Ordinary 2 hole paper punch	No	8
B32	First Aid Kit	No	6
B33	Fire Extinguisher	No	6
B34	Firing Tray	No	10
B35	Waste paper basket	No	20
B36	Refrigerator minimum capacity 0.5 m ³	No	2
B37	Table - 0.8 m ² surface area	No	2
B38	Wall mount able Cupboard 1.5 m ³ lockable	No	2
B39	Cooker 4 plate electric cooker with oven and grill	No	1
B40	Water dispenser: Hot and Cold	No	6
B41	Microwave 20 litres	No.	2
B42	Dustbin	No.	2
	Other Items		
B43	Inkjet Plain Paper Fax Machine with 4MB of memory	No	1
B44	Pencil sharpener (desk mounted type)	No	6
B45	Heavy - duty 2 hole paper punch	No	2
B46	Ordinary 2 hole paper punch	No	8
B47	First Aid Kit	No	6
B48	Fire Extinguisher	No	6
B49	Filing Tray	No	20

B50	Waste paper basket	No	20
B51	Refrigerator minimum capacity 10 m ³	No	2
B52	Table - 0.8 m ² surface area	No	2
B53	Wall mountable Cupboard 1.5 m ³ lockable	No	2
B54	Cooker 4 plate electric cooker with oven and grill	No	1
B55	Water dispenser: Hot and Cold	No	6
B56	Microwave 20 litres	No.	2

APPENDIX C: Surveying Equipment (To revert to Employer)			
NOTE: THE WHOLE OF THIS BILL IS PROVISIONAL AND ISSUBJECT TO REVIEW AT TIME OF IMPLEMENTATION			
ENGINEER'S SURVEY EQUIPMENT (Ownership to revert to the Employer upon completion of contract.)			
C1	Latest version of TOPKON Realtime Kinematic (RTK) GPS	No.	1
C2	Laser Beam Setting Out System	No.	1
C3	Engineer's Electronic Level Wild NAK2 , or similar (2 mm accuracy) with accessories and tripod	No.	4
C4	Tripods wild GST/20 or equivalent	No.	4
	Total station complete with a Field Data collector TOPCON Model GTS-701 , or similar including accessories (charger, batteries, etc) and supporting software	No.	2
C5			
C6	Survey umbrella	No.	3
C7	Levelling staff 5 m with levelling bubble (Wild GNLE 3 or similar)- Foldable	No.	8
C8	2.5m ranging rod	No.	10
C9	1m stainless steel straight-edge	No.	1
C10	3m aluminium straight-edge	No.	1
C11	30m steel white face tape	No.	6
C12	100m steel band tape	No.	4
C13	50m fibre glass tape measure	No.	5
C14	Steel tape repair outfit	No.	1
C15	Ordinary Pangas (16")	No.	4
C16	Echo Sounder	No.	1
C17	Handheld GPS - as type Garmin GPS 72H or similar approved	No.	3
C18	Reflectors with mounts	No.	6
C19	Triple prism mount reflectors	No.	2
C20	Trumeter Or equivalent wheeled measuring metre	No.	1
C21	Ranging rods 2.5m	No.	10
C22	Ranging rods 2.5m (metal, joinable)	No.	10
C23	Optical squares	No.	4
C24	Spare batteries	No.	4
C25	Rapid charger	No.	1
C26	Tribrachs	No.	4
C27	Steel hammer (4kg)	No.	4
C28	Spirit level for staves	No.	4
C29	Metal pocket rulers (5m)	No.	12
C30	Reflective road safety vests	No.	15
C31	Drawing boards (field book frames A4)	No.	10

APPENDIX D- SUPERVISION VEHICLES

Vehicle Type	Specifications	Quantity
Type 1.	New Turbo diesel propelled 4WD, 5 door 7-seater station wagon vehicle of minimum engine capacity 3000cc, 410Nm@ 1600rpm, 125kW/3400rpm power, 90trs fuel tank capacity fitted with all the necessities mentioned in paragraph one of this clause for the exclusive use of the Engineer. To revert to the Employer at the end of contract.	1
Type 2.	New Turbo diesel propelled 4WD, 4 door 5-seater Double Cabin pick up vehicle of minimum engine capacity 2500cc, 110kW/***rpm power, 1301trs fuel tank capacity fitted with all the necessities mentioned in paragraph one of this clause for the exclusive use of the Engineer. To revert to the Employer at the end of contract.	~1