ATHI WATER WORKS DEVELOPMENT AGENCY
Nairobi
Republic of Kenya

Financial Cooperation between Kenya and Germany, with Support of KfW Development Bank

NAIROBI SATELLITE TOWNS WATER AND SANITATION DEVELOPMENT PROGRAMME; PHASE 1

Construction of Mwihoko Water Supply Project – Lot 4

BMZ No. 2013.6543.6

TENDER No. AWWDA/KfW/NST /LOT 4/2023

BIDDING DOCUMENT, FINAL

VOLUME II

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NAIROBI SATELLITE TOWNS WATER AND SANITATION DEVELOPMENT PROGRAMME; PHASE 1

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TENDER No. AWWDA/KfW/NST/LOT 4/2022

BIDDING DOCUMENTS

Bidding Documents have been compiled in the following Volumes:

i) **Volume I** - Instructions to Bidders, Bid Data Sheet, Evaluation and Qualification Criteria, Bidding Forms, Bills of Quantities, Works Requirements, Conditions of Contract and Contract Forms

ii) **Volume II** - General and Particular Specifications

iii) **Volume III** - Engineering Drawings

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VOLUME II

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1. GENERAL

All materials, equipment and testing apparatus etc. to be furnished and Works to be executed by the Contractor in this Contract shall be of the highest standard and conform to the requirements of the latest European Norm (EN), Deutsches Institut für Normung (DIN) or British Standards (BS). International Standards Organization (ISO) will also be accepted where applicable. If any other standard is proposed then it must be the same or more stringent and the Engineer is not obliged to accept it.

Equipment to be purchased shall be from well recognized manufacturers whose products are standardized and controlled by any recognized Standards Organization.

All dimensions and measurement units shall be in S.I. units.

The equipment to be employed by the Contractor shall have sufficient performance capacity and durability as to secure the completion of the Works within the construction period stipulated under the Contract. All materials and equipment shall be subject to inspections or tests by the Engineer at any time and in any state of completion both off-site and on-site as he deems necessary. **The Contractor shall furnish promptly, without additional charge, all facilities, labour and materials reasonably needed for performing such inspections and tests as may be required by the Engineer.**

101. LEVEL DATUM

Before the commencement of Construction Work the Contractor shall establish, in a position to the approval of the Engineer, a bench mark comprising of steel datum pegs which shall be securely concreted in. The level of these pegs shall be established and agreed with the Engineer and all levels used in the construction of the Works shall be referred to these established datum points. The correctness of this datum shall be checked at regular intervals during the construction period as agreed with the Engineer.

Where possible construction drawings and all levels used for construction shall be referred to the national height datum as defined by the Survey of Kenya. The Contractor shall be responsible for obtaining the location and values of the permanent bench marks. In cases where such bench marks do not exist, the site datum shall be agreed with the Engineer.

102. SETTING OUT OF THE WORKS

The Site Layout Drawings show indicative Site Layouts. Prior to commencing construction, the Engineer will agree with the Contractor the basic information supplementary to that shown on the Drawings such as the position of manholes, chambers, centre-lines and base-lines sufficient for the Contractor to locate the Works.

The Contactor shall prepare detailed Setting Out Drawings and Data Sheets as necessary and submit them to the Engineer in triplicate for approval. Any modifications to the Setting Out Drawings or Data Sheets required by the Engineer shall be made by the Contractor and resubmitted for final approval. Should it be necessary during setting out or during construction for the approved setting out details to be amended, the Contractor shall amend the Drawings or Data Sheets or make new ones for approval as required by the Engineer.

For water pipelines, sewers, etc. the Contractor shall in the presence of the Engineer set- out the pipeline alignments in accordance with the indicative alignments shown on the drawings taking

into account physical features on the ground, any existing services, any requirements of relevant Authorities and any changes deemed necessary by the Engineer, confirming the locations of all valves, air valves, washouts, hydrants, bends, manholes, etc.

The Contractor shall prepare and submit to the Engineer, at an approved scale, Plans of the Water / Sewerline Pipeline Routes and profiles of ground levels after any initial clearing of the wayleave or easement showing the proposed pipe invert levels and precise chainages for all valves, fittings, manholes, etc. for approval. Following approval the Contractor shall submit to the Engineer two copies of the agreed alignment and profiles.

The Contractor shall also be required to carry out Site / Engineering Survey of demarcated land where permanent structures / appurtenances will be constructed as directed by the Engineer after initial clearance of sites. The Contractor shall prepare an updated layout plan with contours at 1.0m interval. The contours shall be generated from a 10x10m grid topo survey.

103. CONTROL OF TRAFFIC

In the event of single way traffic becoming necessary on any particular section of the Works, or on the approaches to the Works, the Contractor shall, in maintaining through traffic routes, provide a width of at least 3 metres for single way traffic. He shall also provide approved electrically operated signals for traffic control on each of the affected sections and any additional traffic signs as may be directed in accordance with Clause 108. Signal lights are to be operated by competent operators provided by the Contractor, if and when required by the Engineer. Manually operated "Stop-Go" signs will only be permitted if approved by the Engineer, and shall be of the size, colour and type authorized. The Contractor shall be responsible for liaison with Police.

104. TEMPORARY DIVERSION OF TRAFFIC

Temporary diversion ways, including those listed in any schedule to the Bill of Quantities shall be constructed whenever the site is intersected by existing public and private roads, footpaths, cycle tracks, farm accesses, temporary and accommodation roads.

Any diversion way shall be of such a standard of construction that it is suitable in all respects for the class or classes of traffic requiring to use it. It shall be constructed in advance of the taking up of the existing way and regularly maintained for so long as required in a satisfactory condition all to the approval of the Engineer.

105. TEMPORARY TRAFFIC SIGNS

The Contractor shall erect and maintain on the Works and at prescribed points on the approaches to the Works, all traffic signs necessary for the warning, direction and control of traffic and the size of all such signs and the lettering and wording thereon shall be reflectorised or adequately illuminated at night by approved means.

106. PROTECTION OF WORKS

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

107. SURVEY BEACONS

During the progress of the Works, the Contractor shall not remove, damage, alter or destroy in any way whatsoever, any plot or survey beacons. He shall notify the Engineer of the need to

interfere with any beacon. The Engineer shall authorize any removal and reinstatement that he considers necessary. Should any beacon be found to be above or below the level of the finished work, the Contractor shall immediately report the same to the Engineer.

Should any beacon be damaged or destroyed, the Contractor shall forthwith report the damage to the Engineer and to the Director of Surveys and shall be held liable for the cost of reinstatement thereof.

108. DAMAGE TO LAND

The Employer shall provide the Site upon which the Permanent Works are to be constructed. Where a drain or pipeline is to be within an existing road or track reserve or is otherwise located in land designated Public Domain, the Site width will be restricted to the limit of the public land. The existing boundary fences and walls shall not be disturbed without prior approval of the Engineer and, unless road diversions and closure notices are approved and posted, carriageways shall be left available for the safe passage of traffic.

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

The Contractor shall not enter upon or occupy with men, tools, equipment or materials any land other than the site without the written consent of the owner of such land.

On occupation of the Site or other land the Contractor shall provide such fencing, as required.

109. RIVERS AND DRAINS

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

110. WORKS IN ROADS AND FOOTWAYS FOR WATER MAINS AND SEWER CROSSINGS

The Contractor shall allow in his rates for liaison with the relevant Roads Authority and obtain a Road Opening Permit. The Contractor shall also be responsible for all liaison with the Police for traffic control during execution of the works.

111. TEMPORARY WORKS

The Contractor shall provide, maintain and remove on completion of the Works all temporary Works including roadways, sleeper tracks and stagings etc., over roads, footpaths, suitable in every respect to carry all plant required for the work or for providing access or for any other purpose.
Details of Temporary Works shall be submitted in advance to the Engineer for his approval and the approval shall not relieve the Contractor of complete responsibility for their safety and satisfactory operation.

112. LIGHTING AND GUARDING OF OBSTRUCTIONS

The details of the method of signing and guarding an obstruction to traffic caused in the course

of the execution of the Works shall be submitted to the Engineer for approval before that portion of the Works is commenced.

No greater area of the road than the Engineer considers necessary shall be closed at any one time.

For temporary traffic signs, generally the following precautions will be required:-

Signing

An advance warning sign at least 1.22m x 0.92m in size and 70 metres in advance of the obstruction will be required, and where an appreciable change of direction is necessary at the obstruction, a sign (of the arrow or chevron type) at the obstruction itself. At particular danger points more comprehensive signing may be required.

Guarding

The obstruction shall be marked by posts carrying red flags or reflective red markers and by red lamps. The latter shall be spaced at 6 metres intervals in the direction of traffic flow and at 0.9 metres intervals across this direction. At least 3 lamps shall be placed across this direction of traffic flow. The flags and lamps on the traffic side of the obstruction shall be at least 5 metres from it.

Footpaths

Where a footpath is affected by an obstruction in any way it shall be separated from both obstruction and traffic by effective banners and red lamps spaced at 0.9 metres intervals.

113. EXISTING SERVICES

Before commencing Works which include excavation or ground levelling by manual or mechanical excavation the Contractor shall at his own expenses ascertain in writing from Telkom Kenya, Kenya Power & Lighting Co. Ltd. and all other Public Bodies, Companies and persons who may be affected, the position and depth of their respective ducts, cables, mains, pipes, or other appurtenances. He shall thereupon search for and locate such services.

The Contractor shall at his own expense arrange to have effectually propped, protected, underpinned, altered, diverted, restored and made as may be necessary, all water courses, pipes, cables or ducts, poles or wires or their appurtenances disturbed or damaged during the progress of the Works, or in consequence thereof.

Except that such services as require to be removed or altered by virtue of the layout of the permanent work, and not the manner in which the work is carried out, shall be so removed or altered at the direction and at the expense of the Employer.
The Contractor shall be liable for the cost of repairs to any services damaged as a result of carrying out the Works and execution of these Works.

114. CONNECTIONS TO EXISTING PIPES AND EQUIPMENT

The Contractor shall be responsible for joining up and making connections between water pipes, sewer pipes, etc. equipment installed by him and existing facilities. The Contractor shall submit to the Engineer a drawing showing the details of the connection, and shall state the date on which the particular connection is required, and the work shall not proceed until the Engineer’s approval has been given.

The Contractor shall be responsible for ensuring the compatibility of new pipes with existing pipework, cables, tubing, equipment, etc.

115. PRIVATELY OWNED OR PUBLIC SERVICES

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

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

116. WATER SUPPLY

The Contractor shall provide for all purposes of the work, an adequate supply of water from a suitable source or sources approved by the Engineer. He must pay the water charges, if any, and make arrangements for supply, transport and distribution.

117. ADDITIONAL LAND

The Contractor shall select and arrange at his own expenses for any temporary occupation of land outside the site which he requires for the efficient execution of the Works. The Contractor must comply fully with all By-laws and Regulations currently in force in the area.

118. USE OF HEAVY PLANT

In the event of the Contractor desiring to use heavy machinery or plant, he shall first satisfy the Engineer that they will be of such size and used in such a manner as not to cause any disturbance or damage in particular to water, electricity, Post Office or other mains, cables and connections or to sewers, culverts etc. or interfere with the line or position of any overhead wires and cables of any sort, telegraph poles, power poles etc.

The Contractor will be held liable for any such damage or disturbance and shall pay the full costs of any reinstatement, relaying, repairing or refixing as may be required, as agreed between the Engineer and the owner affected.

119. PROVISION OF INSTRUMENTS AND LABOUR

The Contractor shall provide at his own expenses all instruments, materials, tools and other things which the Engineer considers necessary for his proper supervision of the Works and shall maintain the same in good order. He shall also provide materials, an experienced Surveyor and labour for attendance on the Engineer and his representatives in carrying out operations connected with the supervision of the Works. All charges arising out of such services shall be deemed to be included in his rates in the Bill of Quantities.

120. ACCESS TO SITES

The Contractor shall construct and maintain all temporary accesses required for the execution of the Works. Access roads shall be constructed and maintained up to the Site Offices if required. The cost of all these Works shall be deemed to be covered by rates and prices quoted by the Contractor.

121. TREE PROTECTION

Trees within the permanent and temporary easement are the property of owners. Specific trees will be identified by the Engineer, prior to construction, and the Contractor shall neither remove nor cut their roots unless otherwise directed by the Engineer. If the roots of such trees appear within the trench areas, the Contractor shall handle the roots with maximum care so that no portion of the roots will be damaged. During the excavation of the trench, the exposed roots may be removed to a position that will not damage the roots and will not interfere with the pipelaying. During the construction, the roots shall be thoroughly protected by appropriate cover and wetted as directed. After the pipes are laid, the moved roots shall be placed back to the original locations and backfilled carefully by selected soft soil which can support vegetation.

122. GEOLOGICAL DATA

Any geological data that is made available to the Contractor and is relevant to the Works, will be for his guidance only, and no guarantee is given that other ground conditions will not be encountered. No claims based on the geological data provided shall be entertained by the Engineer.

123. WATCHING, FENCING AND LIGHTING

The Contractor shall arrange to employ watchmen to guard the Works both during the day and night from the commencement of the Works until the substantial completion of the Works.
Any excavation or other obstruction likely to cause injury or damage to any person or domestic animals must be fenced off as directed by the Engineer.

124. TIPS

The Contractor shall be responsible for provision of all tips, at his own expense, for disposal of all spoil or other rubbish collected during the construction of the Works. Any surplus excavated material not required shall also be carted away to these tips. The Contractor to liaise with the local Authorities for approval of location of tips.

125. TROPICALISATION

In choosing materials and their finishes, due regard shall be given to the tropical conditions of the site to which they will be subjected. The Contractor shall submit details of his practices which have proven satisfactory and which he recommends for application on the parts of the Works which may be affected by the tropical conditions.

126. MONTHLY SITE MEETINGS

Throughout the project period, site meetings will be held at the Resident Engineer's Office once every calendar month to discuss the progress of the work, schedule for the ensuing month, methods of construction, procurement, transportation, labours, etc. These meetings can be called at any other time intervals at the request of the Contractor or as directed by the Engineer. The meetings will be attended by Representatives of the Client, Supervision Team and the Contractor. Costs of holding the meetings shall be deemed to be covered under the Contractor's rates.

In addition, weekly technical meetings and other ad-hoc meetings will be arranged and the Contractor will be required to attend.

127. INSPECTION BY ENGINEER DURING DEFECTS LIABILITY PERIOD

The Engineer will give the Contractor due notice of his intention to carry out inspection during

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

128. SUBMISSION OF SAMPLES

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

129. RESPONSIBILITY FOR ORDERING MATERIALS AND MANUFACTURED ARTICLES AND SAMPLES FOR TESTING

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

With regard to any item in the Bill of Quantities which is the subject of a P.C. Sum, the Contractor shall notify the Engineer of his requirements as early as possible leaving ample time for the Engineer to make any necessary arrangements so that no delay occurs in the progress of the work.

130. TESTS OF MATERIALS AND MANUFACTURED ARTICLES BEFORE USE

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

131. REJECTED MATERIALS

Should any material or manufactured articles be brought on to the site of the Works which are in the judgement of the Engineer unsound or of inferior quality or in any way unsuited for the work in which it is proposed to employ them, such materials or manufactured articles shall not be used upon the Works but shall be branded if, in the opinion of the Engineer, this is necessary and shall forthwith be removed from the site of the Works, all at the Contractor's expense and in each case as the Engineer shall direct.

132. QUALITY OF MATERIALS AND WORKMANSHIP

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

133. QUALITY ASSURANCE

As per the GCC, the Contractor shall institute a quality assurance system to demonstrate compliance with the requirements of the Contract.

The Contractor shall employ a full quality assurance system for all phases of the project including design, procurement, construction, testing, O&M and training phases. The QA system shall be in accordance with the general requirements of ISO 9001.

All manufactures and sub-contractors shall also employ quality assurance systems in accordance with the general requirements of ISO 9001.

The Contractor shall submit to the Engineer a full quality plan for the project 30 days after commencement date covering the following:

Outline Quality Plan

- Company QA Policy Statement
- Company Organizational Structure
- Authority and Responsibility Schedule for the contract
- List of quality procedures and instructions
- Inspection and test plans

Full Quality Plan

Procedures and instructions to assure quality for all the works on and off the site including the following:

- Contract Review
- Design Control
- Document Control
- Purchasing
- Subcontract administration and control
- Identification and traceability
- Supervision of construction
- Inspection, measuring and testing equipment
- Non-conformances
- Corrective action
- Handling, storage, packaging and delivery
- Internal quality audits and audit program
- Training

134. OPERATION AND MAINTENANCE MANUALS

The Contractor shall provide Operation and Maintenance (O&M) manuals covering the new plant installed under the Contract. The proposed sequence of submissions is as follows:

i. Prepare draft Table of Contents (TOC), with a brief description of the contents of each section, and submit to the Engineer for comments;

ii. Revise the draft TOC to reflect the Engineer's comments;

iii. Prepare first draft and submit to the Engineer for comments;

iv. Revise the first draft to reflect the Engineer's comments, prior to operator training;

v. Conduct operator training using draft O&M manuals:

vi. Revise draft O&M manuals based on feedback from training;

vii. Submit to the Engineer for further comments;

viii. Finalize O&M manual to reflect the Engineer's comments prior to commencement of the Defects Liability Period.

The O&M manuals shall include, but not be limited to, the following sections:

i. List of suppliers/ manufacturers including contact details and key equipment provided by each supplier;

ii. Register of all items of mechanical equipment, including model no., description, quantity, nameplate information including unique serial number, etc.

iii. Manufacturer’s specifications, data sheets, performance charts, dimensional drawings, assembly / installation drawings, bills of materials, packing, storage, installation, maintenance and troubleshooting instructions. Information shall be specific rather than generic in nature and the model number / size / capacity of each item installed shall be clearly identified;

iv. Copies of Manufacturer's warranties;

v. Copies of certificates of tests performed during manufacture and during performance testing on site;

vi. Spare parts lists for each piece of equipment, with manufacturers’ part number, name and recommended replacement period;

vii. Inspection and preventative maintenance schedules for various periods e.g. daily, weekly, monthly, quarterly, six monthly, annually etc. Each inspection and maintenance shall be described in detail with reference lo manufacturer's information where applicable;

viii. Issues of safety relating to the entering valves pits and operation of the valves, etc.;

ix. Template O&M forms including, but not limited to maintenance, repairs, problems / malfunctions, breakdowns, job sheets, order forms, operational forms and meter

readings, etc.

Substantial completion of the Schemes will not be considered until such detailed information as is required in triplicate has been submitted by the Contractor and has been accepted by the Engineer.

135. PROGRAM OF WORKS

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

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

The program (or, if necessary, a secondary program similarly formulated) shall clearly indicate the various work teams by discipline, including specialist sub-contracts and suppliers, as well as the Contractor's major plant and staff requirements, in order to demonstrate sequencing and non-conflict of resources.

The Engineer may request summary versions of the program, or additional detail for critical sections. The Contractor will comply with all such requests.

Once a Work Program has been approved by the Engineer it shall remain as the current version until such time as the Engineer instructs the Contractor to update or revise the program. The Contractor shall not modify his program without such instruction from the Engineer. Specifically, the Contractor's progress reports shall relate to the current program, and any delays shall be duly indicated.

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

In preparing the CPM Network and the Time Bar-chart Schedule the Contractor shall make due allowances for possible delays. Under no circumstances shall the CPM Network or the Time Bar-chart Schedule show a completion in excess of the “Time for Completion” stated in the Form of Bid.

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

The Contractual Program approved shall supersede all other Programs and shall be deemed to be the Program on which the Contractor has based his Contract Sum and in accordance with which

he will undertake the execution of the Works. This Program shall become part of the Contract.

The Contractor shall ensure that all the Works especially Electrical and Mechanical Works which may be carried out by the Electrical/Mechanical Sub-Contractor, are well coordinated with the overall Works under the Contract for the efficient execution of the Works, and shall clearly indicate them on the construction Program.

The Contractor shall also describe the conditions of working shifts, if necessary, to execute the Works and whether work needs to be carried out at night and/or on Sundays and holidays. The Contractor should also indicate which particular Works are subject to these timings in his construction Program.

Whenever the Contractor proposes to change the Contractual Program, approval of the revision shall be obtained in writing from the Engineer.

If the Contractor has fallen behind the approved Contractual Program or can foresee delay(s) therein, he shall, immediately after such default or event occurred or foreseen or at the request of the Engineer submit a revision of the Contractual Program showing the reasons of such a delay and the proposed measures to recover such delay or to complete the Works on time, for the approval of the Engineer.

The Program shall comprise the minimum of a detailed resource and cash flow schedule for the work. This schedule, to be finalised and agreed between Employer and Contractor, will be used to measure Value of Work Done to enable the Contractor and Employer to monitor the progress of the project in terms of integrated cost, schedule and technical performance measures. In order for Value of Work Done to be estimated, the Contractor will provide a system that can accurately and demonstrably measure the following three fundamental factors:

i. The PLANNED VALUE COST also known as the Budgeted Cost of Work Scheduled (BCWS). This is the amount of expenditure the Employer anticipated he would have spent at time of reporting.

ii. The ACTUAL COST of the progress made, known as the Actual Cost of Work Performed (ACWP). This is the actual amount of expenditure the Employer incurs at time of reporting.

iii. The EARNED VALUE, known as the Budgeted Cost of Work Performed. This is the percentage complete

Payment within the Contract will be based on the achievement of earned value agreed between Employer and Contractor, independently assessed by the Engineer, in accordance with the value achieved based on measured quantities of work done.

136. METHOD STATEMENTS

If the Engineer requires that any Method Statement submitted with the Bid requires revision, then the Contractor will within 28 days of signing the Contract, submit a Revised Method Statement to the Engineer for his Approval. Additional Method Statements will be prepared for all work activities, as required or requested by the Engineer. No works will be permitted without an approved Method Statement.

The Method Statements shall describe the Contractor's overall approach to the Contract, including issues such as type, number and layout of Contractor's buildings, stores and facilities; provision

of temporary services: personnel issues including management structure, supervision and labour; Contractor's plant and equipment, and maintenance thereof; quality control management procedures; general methods for key work components such as structural works, electrical-mechanical installation, construction of pipelines etc.; working adjacent to existing River Courses and any other special considerations, etc.

From time to time the Engineer may request detailed Method Statements for specific activities. The Contractor shall comply in full with the Engineer's requirements.

137. PROGRESS REPORTS

The Contractor shall submit a monthly progress report to the Engineer. The formal, content and level of detail shall be determined and agreed by the Engineer.

If the Engineer considers it necessary, the frequency of reporting may be increased. Alternatively, the Contractor may be instructed to provide a special progress report for a particular section of works (that is significantly delayed for example), on a more frequent basis (e.g. weekly, or even daily). The Contractor’s rates in his Bid are deemed to cover these costs.

138. DAILY LOGS

The Contractor shall maintain a daily site log. The log book entries shall be prepared in triplicate, with one copy being delivered each day to the Engineer.

The content and format of the Daily Log shall be agreed with the Engineer upon commencement of the contract. However, typically the log shall include the date, weather, numbers/movement of plant and labour, main areas of work and daily activity/progress, deliveries of plant and materials to site, tests, issues, shut-downs, key instructions, accidents, among others.

In addition the log sheet shall have a space designated for comments by the Engineer.

The Engineer may, at his discretion, instruct the Contractor to provide daily labour and plant returns. Alternatively, the Engineer may request to review such information.

In addition, the Contractor shall provide the Engineer with copies of all delivery notes of plant and materials delivered to site. The Contractor’s rates in his Bid are deemed to cover these costs.

139. TEST FORMS

The Contractor shall prepare, to the satisfaction of the Engineer, test forms to be used for the various components of the works.

All test forms shall be completed, signed and dated by the appropriate persons conducting the tests. The original copy of all test forms shall be submitted to the Engineer. The Contractor’s rates in his Bid are deemed to cover these costs.

Test forms shall be submitted to the Engineer regardless of whether the test passes or fails.

140. MISCELLANEOUS FORMS

The Engineer and/or Contractor shall prepare other forms as necessary. These may include, but are not limited to:

i. Site Instruction Form;
ii. Request for Information / Inspection / Approval Form;
iii. Notification of non-compliance Form
iv. Materials Supply Form;
v. Setting Out Works Form;
vi. Pipeline Final Excavation Level Form;
vii. Pipeline Laying Form;
viii. Pipeline Backfilling Form;
ix. Pipeline Testing Form;
x. Dayworks Form; and
xi. Concrete Pour Form; etc.

141. CERTIFICATES OF COMPLETION

The Engineer shall prepare such forms in accordance with the Conditions of Contract. These include:

i. Taking-Over Certificate, issued upon successful completion of the Tests on Completion
ii. Performance Certificate, issued upon expiry of the Defects Liability Period and successful completion of defects and all other requirements under the Contract.

142. CONTRACT DOCUMENTS

Without affecting the provisions in the Conditions of Contract, the Contractor shall print and submit at his own cost to the Employer at least ten (10) bound copies of the Contract Documents in the form and manner approved by the Employer. The Contractor's rates are deemed to cover these costs.

143. COMMISSIONING PLAN

At least one month prior to the proposed commencement date of pre-commissioning and commissioning of the Works, the Contractor shall submit to the Engineer for consideration a Commissioning Plan in both hardcopy and digital formats.

The Commissioning Plan shall set out in narrative and summary tabular forms, a list of the proposed precommissioning and commissioning activities to be carried out, for each equipment item, together with proposed start and finish dates.

The format of the summary table portion of the Commissioning Plan shall be similar to Inspection and Testing Plans to be submitted by the Contractor in support of his Quality Plan.

Any interdependencies and specific sequencing issues concerning the commissioning of equipment items shall be clearly detailed and shown on the summary table.

The need for any shutdowns or isolation requirements shall also be indicated.

The Engineer shall review the Commissioning Plan and advise the Contractor of acceptance or otherwise. If the Plan is accepted by the Engineer, the Contractor shall make the necessary preparations to commence commissioning activities as soon as practicable thereafter. If rejected by the Engineer, the Contractor shall attend to any deficiencies noted, revise the Plan and resubmit to the Engineer for approval. The Contractor shall not be entitled to claim additional time or costs as a result of having to revise his Commissioning Plan.

A copy of the Commissioning Plan, complete with check-lists indicating that all pre-commissioning and commissioning activities have been completed, shall be submitted to the Engineer. When commissioning activities have been completed, copies in both hard-copy and digital formats should be forwarded to the Engineer.
Where necessary, commissioning shall be undertaken in conjunction with the respective suppliers for plant, pipes, valves, etc.

144. AS-BUILT AND RECORD DRAWINGS

The Contractor shall prepare, and keep up-to-date, a complete set of "as-built" records of the execution of the works, showing the exact "as-built" locations, sizes and details of the work as executed, with cross references to relevant specifications and data sheets. These records shall be kept on the Site and shall be used exclusively for the purposes of this specification. Two copies shall be submitted to the Resident Engineer prior to the commencement of the Tests on Completion of Works.

In addition, the Contractor shall prepare and submit to the Resident Engineer "as- built-drawings" of the works, showing all works as executed. The drawings shall be prepared as the works proceed, and shall be submitted to the Resident Engineer for his inspection. The Contractor shall obtain the consent of the Resident Engineer as to their size, the referring system, and other pertinent details.

Prior to substantial completion and Handing Over of the Works, the Contractor shall deliver to the Engineer one complete set of record ("as-built") drawings of all works constructed under the Contract, including all underground works such as pipes, services, cables and conduits.

The Engineer shall review and comment on the draft Record Drawings, and within a further two (2) weeks of receiving the comments, the Contractor shall produce a final set of drawings.

If, during the Defects Liability Period, the Contractor modifies any of the Works, the modifications shall be included as amendments to the As-Built Drawings and all other affected documentation.

Prior to the issue of any Taking-Over Certificate, the contractor shall submit to the Resident Engineer one full-size original copy, six printed copies of the relevant "as-built-drawings" and the corresponding computer files (AutoCAD, Excel, MS Word, etc.) on CD-ROM and any further Construction Documents specified in the Specifications. The works shall not be considered to be completed for the purposes of Taking-Over until such documents have been submitted to the Resident Engineer.

The compliance of this Clause by the Contractor is deemed to be covered in his rates as quoted in the Bid.

2. ENVIRONMENTAL, SOCIAL, HEALTH AND SAFETY MANAGEMENT OF THE WORKS

201. STANDARDS AND APPLICABLE REGULATIONS

The Contractor must identify all applicable laws, permits and regulations in relation to the protection of the environment (water, air, soils, noise, vibration, vegetation, fauna, flora, waste, groundwater) and, pursuant to Clauses 4 and 6 of the GCC, the protection of people (labour law, indigenous populations, standards on occupational exposure, other). The Contractor must list all texts, standards and other regulatory limitations in its Environmental and Social Management Plan (ESMP) and specify the means taken for compliance.

The Contractor must comply with all applicable norms, standards and discharge limit values defined in the national regulations of the Employer's country regulations.

The Contractor must comply with norms, standards and discharge limit values recommended by the specialised international organisations affiliated to the United Nations, as described below. In the event of discrepancies in between international standards and national regulations, the Contractor shall comply with the most stringent requirements.

The specialised international organisations affiliated to the United Nations referred above include:

a) World Bank, including the IFC and its Environmental, Health and Safety guidelines available from http://www.ifc.org/ehsguidelines;

For matters not addressed in the above mentioned IFC document, the most stringent of the norms, standards and discharge limit values of the following institutions shall apply:

a) World Health Organization (WHO);
b) International Labour Organization (ILO) (in particular in pursuance to Clauses 6.20, 6.21, 6.23 and 6.24 of the GCC);
c) International Maritime Organization (IMO).

202. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Within 42 days of Commencement, the Contractor shall submit a Project Specific Environmental and Social Management Plan (ESMP) for approval of the Engineer.

The Contractor must carry out all works in accordance with Kenyan Environmental Laws and Regulations, and the requirements of this document.

It is also a contractual obligation for the Contractor to take full cognizance of the environmental and social concerns and requirements as stipulated in the Employer's Environmental and Social Management Plan (ESMP) prepared for this Project and which is given in the Particular Specifications. The full Environmental and Social Impact Assessment (ESIA) Report will also be issued to the Contractor on Award.

Accordingly, the Contractor shall be required to prepare a site-specific Environmental and Social Management Plan (ESMP) for the project. This site-specific ESMP shall be based on the Contractor's evaluation of the requirements of these Specifications and the Employer's ESMP.

The site-specific ESMP shall be submitted to the Engineer for approval within 42 days of Commencement.

The site-specific ESMP shall generally comply with the guidelines set out below.

The site-specific ESMP is the Contractor's operative document on how to enforce, mitigate, inspect and monitor potential Project impacts during mobilization, construction and demobilization. In this sense, it is an eminently practical and concrete instrument.

Based on the above, the structure and content of the site-specific ESMP shall emphasize the following aspects:

i) Executive Summary
ii) Introduction
iii) Project Description
- Focus on impact-generating activities (e.g. demand of water and permanent materials, earth movement, etc.);
- Environmental liabilities: identify and include a photographic registry of pre- existing environmental liabilities (e.g. gully erosion areas, abandoned borrow pits, unauthorized dumping sites, etc.) that are not attribute to the implementation of the Project.

iv) Potential Impacts during Mobilisation, Construction and Demobilisation
- Apply simple rating of significance;
- Quantity/quality impacts (e.g. surface and type of vegetation to be removed, amount and type of wastes to be generated, noise levels, etc.);
- Identify places where specific impacts will manifest

v) Mitigation Plan
- Specify the detailed measures to mitigate the identified impacts (also by location)
- Include designs for measures requiring structural solutions (e.g. gabions, etc.);
- Include the schedule of implementation of mitigation measures in relation to the general construction schedule;
- Health and Safety Plan (detailed);
- Waste Management Plan (detailed);
- Traffic Management Plan (detailed);
- Training Program (detailed);
- Accident and Emergency Response Plan (detailed);
- HIV/AIDS Awareness and Prevention Program (include only a reference to this program to be prepared by an NGO);
- Community Relations Program;
- Location and technical specifications for installation and operation of campsites, including workshops, garages, laboratories, offices, communal kitchenette / dining facilities, sanitary installations, etc.;
- Location, and technical specifications for operation of quarries and borrow pits, and procedures for negotiation with and compensation of land owners where they are located;
- Location and technical specifications for installation and operation of concrete batching, stone crushing, cement mixing and asphalt plants;
- Location and technical specifications for installation and operation of

temporary and permanent dump sites.

vi) Inspection Plan
- Inspection function: specify frequency, locations and instruments (e.g. checklists, site reports, photo registry, etc.) to conduct site inspections;
- Permitting: required environmental permits and schedule to obtain them;
- Specific actions and responsibilities: what, who, where, when, how and why

vii) Monitoring Plan
- Specify, for each variable: frequency of measurement, locations, methods/equipment, units/measures, quality standards, and reporting requirements and periodicity, including establishment of trends.
- Specific actions and responsibilities: what, who, where, when, how and why.

viii) Organisation and Management
- Specify organizational structure, personnel, resource and equipment requirements, reporting requirements and periodicity, and inter-institutional communication and coordination mechanisms.
- Specific actions and responsibilities: what, who, where, when, how and why

ix) Annexes
- If the Contractor wishes to incorporate information beyond the indicated above, such as the policy, institutional and regulatory framework for environmental management in Kenya, biophysical and socio-economic characteristics of the area of influence of the Project, etc., that information should be included as an annex and not in the body of the site-specific ESMP. Preferably, such information should not be attached and, further, if necessary, the pertinent chapter of the ESIA should be referenced.
- Annexes should be used, if necessary, to include detailed information on the specific topics of the ESMP (e.g. inspection forms or checklists, design of structural mitigation measures, photographic registry of environmental liabilities, etc.).

203. PROTECTION OF ADJACENT AREAS

The Contractor shall be responsible for any foreseeable adverse environmental and social impacts arising from its activities and operations and for putting in place any necessary measures to avoid or if not possible mitigate them.

Pursuant to Sub-Clause 4.18 of the GCC, and unless instructed otherwise by the Engineer, the Contractor uses construction methods and means of protection in order to avoid or minimize adverse effects that are incurred on vegetation, soils, groundwater and surface water, biodiversity, natural drainage and the water quality in areas within any Project Area and its surroundings for the entire duration of the works.

Prior to the start of Project activities, the Contractor will stake out the alignments, boundaries and limits of Project sites in accordance with plan(s) agreed upon in advance with the Engineer. Contractor will establish the working strip to restrict the area of impacts to within the working corridor and limit personnel and vehicle movements to only within working areas.

All Project work activities will stay within the staked out alignments and boundaries, and outside the designated ecologically and archaeologically sensitive areas unless specifically authorised by the Employer as part of the Project.

Prior to construction, the Contractor shall place signs with environmental protection information in areas identified as environmentally sensitive, and other areas where sensitive flora and fauna species are situated immediately adjacent to construction areas and that may be inadvertently disturbed or damaged during construction. Sensitive areas may include, but are not limited to, nest sites, plant and wildlife species of high conservation value, site-specific habitat features to be protected.

Wetland areas include marshes, fens, mires or natural or artificial bodies of water, whether permanent or temporary, where water is stagnant or flowing, fresh, saline or briny, including seawater with a low-tide depth of six metres or less. Filling of all or part of a wetland area is not permitted, unless the works are necessary according to the provisions of the Contract or the instructions of the Engineer.

With the exception of access roads, or unless instructed otherwise by the Engineer, the entire perimeter of land sites with a surface area of less than 2 hectares is physically demarcated with a fence or tape. For Project Area with a surface area of more than 2 hectares, the perimeter will be physically demarcated by a perimeter track, road, signs or any other means leaving no possible ambiguity as to the location of the Project Area perimeter.

Unless otherwise specified, the perimeter of the Project Area is at a distance of at least:

a) 50 m from any permanent water course and outside of floodable areas;

b) 300 m from sensitive urban services and buildings (health centre, school, water supply for populations);

c) 200 m from any housing; and

d) 300 m from housing in the specific case of work requiring the use of explosives.

If the footprint of the works are located in the situations a) to d) listed above, and unless agreed upon otherwise by the Engineer, the Contractor will contract a bailiff to make a sworn statement regarding the existence and conditions of residential buildings situated around the site with a distance specified in (h) above.

The Contractor shall perform a topographic survey of all additional areas and facilities, including ground elevations in order to reinstate the land after termination of the works; this includes recording all perimeter GPS coordinates; and ensuring that the entire area proposed for land take or temporary usage is included in the survey and recorded via photographs. Access roads shall be identified as new, upgraded or existing. All data, including GPS coordinates, shall be provided electronically to the Engineer.

The bailiff’s sworn statement is prepared and provided to the Engineer with the Site Environmental Plan.

204. SELECTION OF BORROW AREAS, BACKFILL MATERIAL STOCKPILE SITES AND ACCESS ROAD

The Contractor will submit to the Engineer for prior approval, including but not limited to (i) the location of proposed borrow areas or areas to be excavated, or (ii) proposed backfill material stockpile locations or zones designated for the rubble from demolition works; maintenance facilities, storage areas, batch plants, etc.

This requirement also applies to the side casting during the construction of linear infrastructure (roads, pipelines, transport routes) and which are included in the category of stockpiling of waste material.

a) The opening or rehabilitation of all access routes between Project Areas will be shown on a map and approved by the Engineer prior to the start of the corresponding works.

205. POLLUTION PREVENTION

The Contractor shall take the necessary measures to ensure that pollution to air, water or land is prevented or, where this is not possible, reduced and mitigated as far as practicable during the construction phase. If required in the ESMP the Contractor will develop a pollution prevention Plan for managing e.g. atmospheric emissions and dust, e.g noise and vibrations, e.g waste:

a) liquid effluents (see next clause)

b) air emissions

c) noise and vibration management

d) vehicle and equipment maintenance and selection

e) fuel, oil and chemical storage and handling.

Environmental and/or occupational health and safety regulators will be notified and informed as required by applicable laws about any Environmental pollution. The Contractor shall ensure that all appropriate environmental protection measures are adopted during the clean-up process after termination of works and that clean-up activities are appropriately documented

206. EFFLUENTS

Effluents consist of liquid discharges, including infiltration, from Project Area, transporting a pollutant (dissolved, colloidal or particles).

A pollutant is a given chemical compound that is at a concentration greater than the limit value established for that compound according to the Clause 201.

If no recognized threshold exists for a chemical compound pursuant to above Sub-Clause, the Contractor provides proof that the concentrations of the chemical in effluents released (discharged) to the environment are harmless to it and human beings.

No effluent is discharged by the Contractor neither into water courses or bodies including marine environment nor to ground surface or infiltrated into subsoils, without prior treatment and without monitoring quality of the treatment's performance to guarantee the absence of pollution in the effluent. Effluent discharge and flow rates into natural water bodies will be managed to control erosion/sediment freight.

The Contractor is responsible for carrying out or contracting the monitoring of the effluent quality pursuant to Sub-Clause above by insitu measurements, and sampling and laboratory analysis. In the first case, the Contractor provides the ESHS manager with the resources, equipment and skills to carry out in-situ monitoring and laboratory analysis of the performance indicators. In the second case, the Contractor establishes a contract with a specialised laboratory, accredited with the Employer's country authorities for this activity.

The physical and chemical parameters of an effluent that require quantity and quality monitoring are those listed in the Employer's country environmental regulations or in additional international standards or guidelines, or if these do not exist, the parameters are based on the recommendations of specialised international organisations pursuant to Clause 201. The list of monitoring parameters requires approval from the Engineer.

The Contractor will list, locate, and characterise (flow, expected quality, discharge frequency) all sources of effluents and outlets to the natural environment in the Site Environment Management Plan(s).

The Contractor will submit to the Engineer an Effluent Quality Monitoring Report on a monthly basis, including documentation for the following for each effluent discharge point: (i) average flow rates of discharged effluents, (ii) discharge frequencies and durations over the month, and (iii) the physical and chemical quality of the effluent discharged, for the conformity with parameters listed in Sub-Clauses above.

Wastewater run-off

The Contractor will take appropriate measures to ensure that discharges of process wastewater, sanitary wastewater, wastewater from utility operations or stormwater to surface water will not result in contaminant concentrations in excess of local ambient water quality criteria or, in the absence of local criteria, other sources of ambient water quality.

Rainwater run-off

- Run-off consists of the rainwater flow on the surface or the soil and other technical surfaces at Project Areas.
- In the context of the Contract, surface run-off is considered as an effluent unless demonstrated otherwise, as documented and substantiated by the Contractor, and approved by the Engineer.
- All platforms where generators, hydrocarbon storage tanks and refueling stations are installed have impervious and chemical resistant surfaces are drained separately and equipped with an oil removal treatment (oil-water-separator) to prevent pollution pursuant to Sub-Clauses above. For concrete batching plants, run-off will be drained to settling basin, where the pH will be buffered.

Contractors shall prohibit its workers and its subcontractors from bathing or washing clothes and vehicles/equipment in rivers or watercourses.

207. ATMOSPHERIC EMISSIONS AND DUST

Emissions refer to any discharge into the air of solid substances, aerosols, gases, radiation, or energy, whether point sources (e.g. incineration stack) or diffuse (e.g. fugitive dust emissions from road use by trucks).

The Contractor will use equipment and adopt construction and transport methods with atmospheric emissions which are not in excess of the threshold emission values recommended by the Employer's country standards, or the organisations mentioned in Clause 201.

Once having received the agreement from the Engineer, the Contractor will document the maintenance records for its fleet of vehicles, machinery and equipment. The records will be in the language of communication defined under GCC Sub-Clause 1.4, or any other language approved by the Engineer, and will be at the disposal of the Engineer.

The fleet of vehicles or equipment emitting combustion gases will be maintained at the intervals and according to the methods specified by the manufacturer.

The Contractor shall exercise care to minimize emissions of dust from its activities, including traffic, at work sites, in residential areas and on access roads. Where it is deemed that dust is impacting or may have an impact on human, plant or animal receptors or where dust may cause sedimentation of watercourses/water bodies or unacceptable levels of soil loss, the Contractor shall apply water to the area creating the dust and consider implementing other dust control measures such as using windbreaks, netting screens or semi-permeable fences; controlling vehicle speeds to reduce traffic-induced dust dispersion and resuspension by setting and enforcing speed limits (Contractor vehicle speed limits are specified in Clause 243).

This shall include: posting speed limit signs in sensitive areas; ensuring trucks hauling sand, dirt or other loose materials are covered (sheeting trucks); suspending topsoil stripping and replacement during strong winds; using a dust collection system for bulk materials unloading; wet suppression (as needed, depending on the soil type) in the dry season, where unpaved roads and/or the working strip is located <200 m from settlements taking appropriate abatement measures.

The Contractor describes in the ESMP the road sections designated for the application of dust suppression agents and the methods and frequencies programmed. The Contractor will implement the measures approved by the Engineer.

i. Where applicable, visual inspections of atmospheric emissions shall be conducted, especially dust and emissions from vehicles and machinery as agreed with the Engineer. The inspections shall identify areas where the implementation of dust reduction measures is required,
ii. When storage, transport and handling of bulk materials is made in the open air and exposed to the wind, the Contractor implements the necessary dust abatement measures.

208. NOISE AND VIBRATION

The Contractor uses equipment and adopts construction and transport methods so not to generate noise levels in excess of values recommended by the Employer's country regulations and organisations mentioned in Clause 201.

The Contractor will plan high noise generating works (e.g. pile driving, blasting, rock clearing, drilling, percussion drilling) in line with national regulations and respect maximum ambient noise-levels and night time rest hours at the nearest receptor area. A receptor is defined as an area used for nocturnal socioeconomic activities (e.g. accommodation camps, residential areas, hotels, health centres).

The Contractor shall locate stationary equipment (such as power generators and compressors) as far as possible from nearby receptors (e.g. worker resting areas, populated areas and environmentally sensitive areas). Equipment known to emit noise strongly in one direction, whenever possible, will be orientated so that the noise is directed away from sensitive receptors

The use of heavy vehicles at night is specified in Clause 243.

Standard noise abatement equipment shall be fitted to equipment by the Contractor, used and maintained in accordance with manufacturers' instructions.

209. WASTE

The Contractor is responsible for identifying, collecting, transporting and treating all waste produced on the Project Areas.

The Contractor shall minimize the generation of waste and reuse, recycle and recover waste in a manner that is safe for human health and the environment.

The Contractor shall establish a Waste Management Plan which details a concept to manage non-hazardous and hazardous waste in line with the local legislations and adapted to the level of danger for human health or the natural environment. In absence of adequate legislation, waste shall be managed according to the guidance provided in the respective sections of the General World Bank Group EHS Guidelines with the objective of protecting soil and water resources. The Waste Management Plan shall include provisions for the training of workers.

Waste register and categorization:

The Contractor establishes and maintains a waste register which is at the disposal of the Engineer. This register will record all waste management operations: production, collection, transport, treatment. It will be available as of the Contractors mobilisation to any Project Area. Waste shall be categorized according to the following definitions:

1. Non-hazardous solid waste generated at construction and decommissioning sites includes excess fill materials from grading and excavation activities, scrap wood and metals, and small concrete spills. Other non-hazardous solid wastes include office, kitchen, and dormitory wastes when these types of operations are part of construction project activities.
2. Hazardous solid waste includes contaminated soils, which could potentially be encountered on-site due to previous land use activities, or small amounts of machinery maintenance materials, such as oily rags, used oil filters, and used oil, as well as spill cleanup materials from oil and fuel spills.
3. Hazardous liquid waste includes effluents and waste material containing "free liquids" (e.g used cutting oil or wastewater mixed with oil after cleaning machinery).

The following aspects are documented in this register:

i. Type of waste, using the nomenclature specified above;

ii. Waste quantities;

iii. Name and address of the third party waste management facilities receiving waste or parties taking possession of the substances no longer considered as waste;

iv. Name and address of waste transport Contractors;

v. Planned waste treatment.

In accordance with national regulations, the Contractor files and maintains at the disposition of the Engineer the waste manifests for the collection, transport, treatment and/or elimination of waste.

The Contractor assesses, document and effectively implements any local recycling or re-use options for its waste.

Waste is stored separately prior to removal from the Project Areas, depending on the level of danger, phase (liquid, solid or gas), the waste management solution to be applied and its potential in terms of recycling or reuse.

Waste is collected from each Project Area at the same rate that it is produced and is placed in temporary locations meeting the following criteria:

It shall be located at a distance of over 100 m from any natural sensitive area and over 500 m from any socioeconomic sensitive area (school, market, healthcare centre, water well or catchment area), with the exception of waste storage area in camps; and on a flat impervious surface to prevent infiltrations.

Unless otherwise specified in the Contract or instructed by the Engineer, waste incineration is prohibited on Project Areas. Two exceptions are medical waste and green waste, which unless instructed to the contrary by the Engineer, are managed pursuant to the provisions of the present specifications on waste.

The use of third party waste management services is subject to a documented prior audit of the treatment, storage and recycling facilities by the Contractor, to guarantee the conformity with the provisions of the present specifications on waste.

The provisions applicable to the Contractor regarding waste management also apply to any third-party waste management Subcontractor. The Engineer reserves its right to inspect third-party waste management facilities and prohibit the Contractor from using the facilities if considered unacceptable.

Non-hazardous waste management

The management of non-hazardous waste shall comply with the following conditions:

1. The Employer will communicate information to the Contractor about the location of and distance to the nearest landfill area and the disposal conditions.
2. If no landfill area exists nearby, the Employer will communicate to the Contractor where the Contractor shall establish a temporary landfill area. The Employer is responsible for obtaining the respective permits.

Hazardous waste management

i. The Contractor shall develop a Hazardous Materials Management Plan for those hazardous materials the Contractor is directly responsible for, and detailed procedures for working with chemical products and hazardous materials and handling hazardous waste.

ii. Hazardous materials are those that pose a potential risk to human health or the environment and include cleaning chemicals, solvents and fuels.

iii. Fuel and hazardous chemicals/materials shall be stored in designated areas, pursuant to Sub-Clause 223, except for quantities generated or required for the daily construction activities. Fuel, oil or hazardous materials required to be temporarily stored onsite shall be stored within secondary containment located greater than 100m from a watercourse or water body.

iv. Fuel and hazardous chemical storage areas shall not be allowed within 30m of a minor watercourse, within 100m of a major watercourse, within a floodplain or where there is the potential for spilled fuel to enter groundwater.

v. All fuel and hazardous chemical storage facilities shall be located on flat or gently sloping ground and shall be contained within a bund designed to contain at least 110% of the total capacity of the storage containers plus 10% of the aggregate tank volume within the containment area or as otherwise specified by regulatory requirements. The bund walls and floor shall be constructed of concrete or other suitably impermeable material. The filling connection must be within the bund. No drain valves or other connections through the bund walls shall be permitted. Tanks shall be fitted with a gauge to allow the fill level to be monitored during refilling and preferably with a high-level alarm.

vi. When the Contractor´s hazardous waste management is conducted by third parties, they must be reputable and accredited in the Employer’s country for this activity.

If applicable and in the absence of an existing waste management solution for hazardous waste, the Contractor takes the following action:

i. Medical waste is incinerated in a specific facility constructed and accredited for this purpose. The Contractor will submit the technical specifications of the facility to the Engineer before importing or procuring the equipment.

ii. Hydrocarbons, lubricants, paints, solvents and batteries are transported in drums to suitable waste management facilities available, if available.

iii. If not otherwise instructed by the Engineer, contaminated soils from construction/demolition and drilling muds shall be treated, stabilized and disposed of to landfill. Prior approval is required from the Engineer regarding the method and site location. The Employer obtains authorization from the competent local authorities prior to any disposal to landfill.

iv. Prior approval from the Engineer is required before implementing waste management solutions on any other hazardous waste.

v. Prior to the issue of the Taking Over Certificate for the Works, the Contractor provides documentation on hazardous waste, produced by the Contractor´s works, landfilled at other sites than accredited third party waste management facilities. The documentation includes a plan showing the location of landfill sites. The document is provided to the competent local authorities whose jurisdiction covers the landfill sites.

210. VEGETATION CLEARING

The works, including the opening up of the right of way and other worksites (e.g. camps, access roads, storage yards) may require vegetation clearance in work areas. Vegetation includes crops, trees, shrubs, bushes, grasses and other minor vegetation. Supervisors shall be trained in the controlled felling of trees to prevent impacts beyond worksites. They shall also be trained on the importance of identification and preservation of wild fauna encountered and disturbed during the stripping operation.

The Contractor describes in the ESMP the planned methods and schedule for vegetation clearing. Specific agreement from the Engineer is obtained prior to any clearing works.

Vegetation clearing using chemicals is not permitted. Vegetation clearing using bulldozer is not permitted in zones less than 30 m from areas designated as sensitive by the Engineer, where only manual clearing is authorised.

i. Where it is not possible to restrict the timing of construction practices, vegetation shall be removed outside the breeding period so that works can carry on into this period unhindered.

ii. The felling of trees shall be avoided where possible. Felled trees may be used for building gabions if required for land stabilization. Vegetative material (slash) is not to be used for construction purposes and shall be stockpiled at the edge of worksites. Areas of gathered plant material shall be separated to prevent flames spreading in the event of a fire.

iii. Unless otherwise specified in the Contract or if otherwise instructed by the Engineer, burning vegetation is not permitted. Green waste can be burnt with prior approval from the Engineer regarding the location, method and schedule.

iv. The collection of wild plants is prohibited.

v. Lighting fires in work areas is prohibited unless specifically authorised by the Employer.

vi. It is prohibited to introduce foreign/non-adapted vegetation to the worksites.

vii. Removed vegetation will be placed far from surface water. Large woody debris will be stored along the outside edge of worksites in clear areas. Small twigs, branches and pieces of vegetation shall be used for composting along with biodegradable waste generated in the camp and work areas.

viii. Clearing of vegetation shall be limited to that which is strictly necessary.

ix. Where possible, cutting of vegetation on steep hillsides will be minimal.

Areas cleared prior to undertaking earthworks are shown on a plan with a minimum scale of 1/10,000. Plans are submitted to the Engineer, for validation prior to starting clearing works.

The Contractor undertakes physical demarcation of zones to be cleared using a method approved by the Engineer.

The characteristics (location, species, diameter at chest height) of trees not to be cut down are defined by the Engineer in coordination with the Employer. Such trees are marked with paint and protected against clearing machinery using a method approved by the Engineer.

Trees and areas to be cleared are to be marked precisely so that clearing is undertaken without damage to adjacent non-cleared areas. Topsoil is stored within the cleared areas at the edge of the cleared zone. Clearing is undertaken working from the edge of the zone inwards.

i. During clearing, the Contractor stockpiles separately:

   1. tree trunks with a diameter at chest height greater than the size defined by the Engineer, and
   2. trunks with a smaller diameter, branches, leaves, stumps and roots.

ii. Unless instructed otherwise by the Engineer the trunks of trees exceeding the diameter defined by the Engineer are the property of the Contractor.

211. BIODIVERSITY

The Contractor shall ensure that all personnel are informed and aware of the importance to protect species, habitats, fauna and flora and are informed about wildlife encounter procedures. Information and awareness training is documented.

If applicable, the Employer will provide to the Contractor a range of ecological surveys prior to the start of construction, conducted by the Employer. These will include but not be limited to the type and location of identified species and habitats of conservation interest within the Project Area, and any resulting measures that are required by Contractor.

The Employer will provide to the Contractor a constraints map, showing the areas where sensitive, endangered or breeding species are known to occur, including protected areas, sites of importance for nature conservation, wildlife refuges, nature and national parks, important bird areas.

The Employer will inform the Contractor about seasons for the protection of birds and wildlife. If applicable, the Employer will inform the Contractor if, as a result of protecting birds and wildlife, construction is restricted during a certain period and/or the Contractor must take precautionary measures in compliance with respective national laws and/or as stipulated by the respective local authorities.

The Employer may update information on the presence of wildlife or sensitive or endangered species' in the Project Area following any additional wildlife/endangered species´ survey. If any are identified, the Employer will notify the Contractor who will ensure that all personnel are informed and aware of the required mitigation procedures as communicated by the Employer.

The Contractor shall apply the Contracting Authority's procedures with regards to fauna and flora management prior to clearing activities.

The Employer will communicate to Contractor his specific responsibilities related to protecting endangered species, biodiversity and wildlife, present within the Project Area. Responsibilities may include but not be limited to the following measures:

i. The Contractor´s personnel shall not approach, injure, hunt, capture, possess, feed, transport, rear or trade wild animals and/or collect birds' eggs on the Project Areas

ii. The Contractor´s personnel shall avoid where possible breeding, feeding and nesting sites of endangered species, as identified by the Employer´s environmental experts and as communicated to the Contractor by the Employer.

iii. The Contractor personnel shall not collect flora or fauna species on the Project Areas.

iv. The Contractor shall report any sighting or finding of dead wildlife killed by the works to the Engineer immediately.

v. The Contractor shall protect excavations with temporary fencing to prevent injury to animals.

vi. The Contractor shall release any trapped uninjured animals immediately.

vii. The Contractor shall report injured endangered and/or larger animals to the Engineer who will inform the appropriate Environmental Authority.

viii. The Contractor shall not disturb natural habitats outside the Project Areas.

ix. The Contractor shall only use designated roads or paths and abide by speed limits.

x. The Contractor shall not start forest fires.

xi. The Contractor shall not introduce Invasive Alien Species (IAS)

xii. All construction machinery imported from overseas shall be inspected to detect IAS and washed before dispatching to the Project Areas.

xiii. Where necessary, the Contractor shall develop IAS control procedures (eg physical removal, slashing, mulching, herbicides, etc). Methods used to control or prevent such species shall not cause adverse impacts on the environment or communities.

xiv. To limit the risk of introducing marine invasive species, the Contractor shall control the ballast water and anti-fouling systems of vessels arriving from other bioregions in accordance with International Maritime Organization (IMO) conventions and guidelines.

For impacts to biological resources:

i. development of a specific mitigation plan for endangered species in the wider area

ii. trenches or holes created during site works must be covered at night

Regarding habitat loss/degradation and habitat fragmentation Contractor will:

i. site permanent infrastructure on unused land of no particular ecological value

ii. take no construction materials from the surrounding environment unless otherwise specified in the respective management plan

iii. monitor the impacts on flora and fauna at sensitive locations

The Contractor will adopt best construction site practices to minimize the risks of adverse effects on neighbouring habitats/species from construction activities (dust, noise, waste disposal etc.). This will include appropriate toilet and litter collection facilities as inspected by the environmental coordinator.

212. EROSION AND SEDIMENT TRANSPORT

Erosion and sediment control shall be taken into consideration from the beginning of the construction phase, i.e. from site clearance.

The Contractor plans earthworks and optimises the management of space to ensure that all cleared surfaces and areas exposed to soil erosion are minimised on all Project Areas and erosion is minimised as far as practical.

The Contractor shall determine the appropriate locations and the type of erosion control measures required, to be agreed with the Engineer.

If not instructed otherwise by the Employer, the Contractor shall install erosion matting to provide an immediate protection for slopes against erosion, prevent the washing-out of seeds and enhance the micro-climatic conditions in the soil for plant growth. Erosion matting is used to provide temporary protection of the soil surface until sufficient natural vegetation cover has been established.

Topsoil

i. Topsoil is the uppermost and most fertile portion of the soil (unless indicated otherwise, the top 25 centimeters), containing organic matter, seeds and nutrients that promote vegetation growth. Its presence is a key factor in promoting revegetation success. Consequently, preserving topsoil is a key component of revegetating worksites and restoring the soil's ability to protect itself against erosion. Contractor shall observe the following basic principles of good topsoil management:

ii. Topsoil shall be removed from working areas only when absolutely necessary and in accordance with Project guidelines. Areas subject to topsoil stripping will be identified prior to grading activities.

iii. Any plant, turf layer or root mass will be stripped together with the topsoil, except in wetlands where the turf will be stripped separately from the topsoil layer where practical. Topsoil will be removed using backhoes only.

iv. Topsoil is stored according to the provisions approved by the Engineer to enable reuse during Project Area rehabilitation.

Draining rainwater run-off

i. Run-off from the working corridor will be intercepted. Surface water run-off will not be permitted to enter surface watercourses. Contractor will take appropriate measures.

ii. The gradient of Project Areas allows the collection and drainage of rainwater from the entire surface area to one or several discharge points. No pools of water are created.

iii. Suspended solids in rainwater are removed using sediment traps / settling ponds. Rainwater from vehicle parking areas, machinery areas, workshops is subject to treatment with oily water separators.

iv. Rainwater pre-treatment units are sized, cleaned, maintained and accessible to ensure compliance with the effluent quality criteria defined in ESHS Specifications Sub-Clause 12.9 and to allow monitoring of performance.

Sediment control

i. The Contractor installs sediment control barriers to slow the flow of water and control sediment transport at Project Areas with (i) a gradient of more than 20%, and (ii) where land is disturbed by the works or where stockpiled mineral material exposed to sheet or rill erosion.

ii. Sediment control barriers are installed on the slope or at the base of the slope to protect the natural drainage system from sediment accumulation at levels higher than the natural situation. These barriers comply with the following principles:

   a) Made with geotextiles or straw bales or any other means pre-approved by the Engineer;

   b) Deployed before the start of works and removal of topsoil. Barriers can be used for the physical demarcation of working areas;

   c) Installed, cleaned, maintained and replaced according to manufacturer recommendations;

   d) If applicable, drainage surface area does not exceed 1,000 m² per 30 m of barrier. The length of the slope behind the barrier is less than 30 m, and is not used for flows in excess of 30 l/s.

iii. For the dredging of marine sediments, if applicable and unless specified otherwise in the Contract, or instructed otherwise by the Engineer, and particularly if the working area is exposed to currents, the Contractor will install a geotextile silt curtain, or any other technique approved by the Engineer to control turbidity clouds.

Backfilling and stockpiling of backfill materials

i. In case mineral material stockpiles do exceed a height of 6 m, with a maximum slope of 3:2 (height: volume), the slope has to be crossed at a height of 3 m by a berm with a minimum width of 2 m and with a peripheral drainage trench, to ensure stability and resistance to rainwater runoff erosion.

ii. For permanent backfill material stockpiles, the stockpile is shaped and compacted every 30 cm to ensure long-term stability.

iii. Temporary stockpiles in place for more than 60 days are protected against runoff erosion by (i) revegetation using fast-growing grass species, either by direct seeding or by hydro-seeding, or (ii) using other natural anti-erosion cover with prior approval from the Engineer.

Side casting during the construction of linear structures (roads, pipelines, transport lines), will be permitted in the following conditions:

i. For natural gradients with a slope <40%, the side cast materials are piled to create a slope of less than 2H:1V.

ii. For natural gradients with a slope >40%, to ensure stability 3m wide berms will be installed perpendicular to the slope and onto which the side cast material is deposited. Regular earthworks to maintain the form of the side case and long term stability of the side cast is carried out. The slope of the side cast in general does not exceed 3H:2V.

iii. The provisions of for the protection of water courses exposed to erosion induced by the works apply.

213. SITE REHABILITATION

Unless instructed otherwise by the Engineer, the Contractor will rehabilitate all Project Areas and landscapes disturbed by the works, to their original condition where possible upon completion of construction and prior to the provisional acceptance of the works. Close collaboration with all statutory stakeholders will be conducted in cooperation with the Employer during the reinstatement.

The Contractor describes in the ESMP the planned revegetation works to ensure sustainable Project Area rehabilitation: methods, plant species to be used and their origins, activity schedule based on a progressive taking over of Project Areas.

As a minimum, the Contractor shall carry out the following reinstatement activities:

i. If not otherwise instructed by the Engineer, all buildings, campsites and free standing and underground structures (e.g. piping, underground tanks, sumps and basins) are removed pursuant to the provisions of Sub-Clause 4.23 of the GCC. All waste and rubble is removed in accordance to the provisions specifications. After removal of buildings structures and rubble, the Contractor returns Project Areas to their original condition, according to the following provisions.

ii. Land is levelled to ensure that run-off water drains without eroding soil or stagnating in pools.

iii. Rehabilitated Project Areas do not represent hazards for people. Areas near steep drops at quarries are fenced off and indicated with permanent concrete warning signs. Holes are refilled. Sharp or unstable items are rendered inoffensive.

iv. Unless specified otherwise in the Contract, or instructed otherwise by the Engineer, the Contractor undertakes revegetation of all Project Areas disturbed by the works and bears the cost of such work.

Fertiliser application shall be limited to areas where it is necessary to establish a rapid vegetative cover for erosion control purposes in areas of high risk. Any fertiliser applications must be formulated and performed so that natural nutrient balances in adjacent ecosystems are not altered, particularly where there are nearby water bodies.

The Contractor shall perform routine maintenance of revegetated areas until such time that occupation of the land is officially handed back to the Employer or third parties.

The Contractor shall control noxious weeds and invasive species within revegetated areas.

The Contractor shall supply attendance during the Defects Liability Period to ensure that all planted grass is kept weeded and cut, and watered if necessary.

Prior approval by the Engineer is required regarding the origin of seeds and plants proposed by the Contractor. The species used for revegetation must be suitable for the local environmental conditions, and selected according to the rehabilitation programme: stabilisation of backfill, landscaping, drainage, prevention of erosion, etc.

Revegetation is undertaken throughout the duration of construction works, and is not limited to the rehabilitation of Project Areas at completion of the works.

The present Clause applies to the side casting of waste mineral materials generated during the construction of linear structures (roads, pipelines, transport lines).

214. DOCUMENTATION ON SITE CONDITIONS

The Constructor documents changes in condition of all Project Areas from the start of works until the Performance Certificate is issued. Documentation comprises dated and geo-referenced colour photographs taken from a constant angle and viewpoint.

The Project Area condition is documented as a minimum for the following stages:

i. Before any Project Area disturbance at the start of works;

ii. On completion of works, but prior to starting rehabilitation;

iii. On completion of rehabilitation and revegetation, if necessary, but prior to the Taking Over Certificate issuing;

iv. After the end of the Defects Notification Period and prior to the Performance Certificate issuing.

The Contractor specifies in the ESMP (i) the list of viewpoints to be used, (ii) areas to be photographed, and (iii) methods used for taking and archiving photographs, according to industry photographing and archiving standards.

Adjacent areas (100 m from the perimeter of the Project Area) are included in photographic documentation.

215. HEALTH AND SAFETY MANAGEMENT PLAN

Within 42 days of Commencement, the Contractor shall submit a project specific Health and Safety Management Plan (HSMP) for approval of the Engineer.

The Contractor must at all times comply with the National and Local County Laws and Regulations during the Construction and Commissioning Phases of the Project.

Site-Specific Health and Safety Management Plan

The Contractor shall appoint a full time qualified Health and Safety Manager who shall have responsibility for all safety issues on the Project. The Contractor must submit a site- specific Health and Safety Management Plan (HSMP), which shall, as a minimum, address the following:

1) Introduction (including objectives of the HSMP)
2) Hazard Prevention and Control
    i) Risk assessment (including description of risk assessment method used). Pursuant to Clause 6 of the GCC, the HSMP identifies and specifies:
        a) That Contractor understands and manages all health and safety risks relating to the execution of the works, including gender-specific risks;
        b) Prevention and protection measures to control risks related to thee xecution of the works, by differentiating, where necessary, measures concerning the protection of women and men;
        c) Human and material resources involved;
        d) Works requiring a permit (e.g blasting, butting of trees);
        e) Emergency plans to be implemented in the case of an accident.

    ii) Prevention, protection and control measures (based on risk assessment performed):
        a) Personal protective equipment and clothing: safety goggles, ear plugs, work boots, dusk masks, protective clothing etc.;
        b) H&S and sanitary facilities, equipment, materials and personnel: first- aid kits and stations, health personnel, safe drinking water, sanitary facilities, accommodation, washing facilities, domestic waste disposal, etc.;
        c) On-site safety measures and procedures to protect workers against accidents and health risks in the performance of construction-related activities:
            - Site security: access, safety of visitors, separation of work and rest areas, signage, etc.
            - Handling of raw materials: earthwork, gravel, crushed rock, sand, etc.
            - Handling of other materials causing dust development, such as cement;
            - Handling of hydrated lime and other activators and additives;
            - Handling of asphalt;
            - Hazardous materials management
            - Handling of inflammable materials;
            - Maintenance of vehicles and machinery;
            - Deep Excavation and trenching;

- Emergency prevention, preparedness and response.

iii) Contractor's participation in Health and Safety Training Program
iv) Contractor's participation in HIV/AIDS Awareness and Prevention Program
v) Provide specifics of training and instruction: topics, frequency, modalities, target audiences, instructors, training materials, etc.
vi) Potential Topics:
   - Occupational safety risks and prevention
   - Health risks and prevention
   - Use of personal protective equipment
   - Safe work procedures: general and specific.
   - Organization and Management

vii) Organizational structure, personnel, equipment, communication and reporting requirements, accident and incident reports, and procedures and tools to verify and ensure compliance with occupational health and safety requirements.
viii) Annexes should be used, if necessary, to include detailed information on the specific topics of the HSMP, such as (illustrative list):
   - Accident Report forms.
   - Dangerous Occurrence forms (near misses).
   - Safety Audit Forms.
   - Safety Check List.
   - Safety Rules.
   - List of hospitals, emergency evacuation strategy and other arrangements to treat seriously injured staff.
   - List of personnel trained in first aid and their places of deployment.
   - List of first aid kits and locations where these will be held.

The Contractor shall have in place a Behavioural Safety Based Programme and actively train and encourage Personnel to intervene on unsafe behaviours and situations and report on deviations.

The Compliance of this Clause by the Contractor is deemed to be covered in his rates quoted in the Bid.

216. HEALTH AND SAFETY REPORTING

The Contractor shall document in a structured system (e.g. a Site Accident record sheet) all accidents, dangerous occurrences and investigations which shall be available at all times for inspection by the Engineer.

The Contractor shall investigate any incident and record and report systematic follow-up of relevant findings and recommendations. Problem areas related to HS shall be recorded with information about status, responsible person(s) and alternative solutions.

As specified in Sub-Clause 4.21 of the GCC, the Contractor includes in the Progress Report to the Engineer a monthly HS Performance Report. The format and content of the HS Performance Report shall be agreed with the Engineer prior to the commencement of the works and report them to the Engineer.

In pursuance to clauses 4 and 6 of the GCC, this report shall contain the following data, as related to the works:

i. Progress against implementation of the Contractor`s HSMP
ii. A list, including a brief description, of all incidents and dangerous occurrences
iii. Number of fatalities
iv. Number of serious incident frequency
v. Total Recordable injury frequency
vi. Number and type of accidents with and without lost-time
vii. Serious illness
viii. Total number of 'near miss events;
ix. Number of theft incidents;
x. Number of security and number and type of other incidents;

In the event that the Contractor receives communication from the Engineer on HS under-performance, the Contractor shall prepare and implement an HS Improvement Plan to rectify such.

217. ACCIDENT REPORTING PROCEDURE

The Engineer is informed within one hour day/night of any accident involving serious bodily injury to a member of personnel, a visitor or any other third party, caused by the execution of the works or the behavior of the personnel of the Contractor.

The Engineer is informed as soon as possible of any near-accident (near misses) relating to the execution of the works which, in slightly different conditions, could have led to bodily injury to people, or damage to private property or the environment.

The Contractor shall prepare a report on each accident or dangerous occurrence and a copy of the report, together with witness statements and any other relevant information, shall be submitted to the Engineer as soon as possible.

A reportable accident shall include any accident to any person on Site requiring medical attention or resulting in the loss of working hours or any incident that resulted, or could have resulted in injury, damage or a danger to the Works, persons, property or the environment. Contractors will also notify and report of incidents of Subcontractors and Suppliers (in particular those for major supply items) and their Contractors Sites.

The Contractor shall report any HS accident, related to Contractor activities or personnel, to national or local authorities as required by relevant legislation. A copy of all such reports shall be provided to the Engineer.

The Contractor shall not notify or give any information to the media or other units or people without the employer's consent.

The Contractor shall immediately rectify any situation or condition that could result in injury or a danger to the Works, person, property or the environment. If the situation or condition cannot be corrected immediately, the Contractor shall provide temporary barriers and appropriate warning signs and devices and/or take other appropriate action necessary for the protection of persons, property and the environment.

218. HEALTH AND SAFETY MEETINGS

Contractor shall ensure efficient and effective HS communication and consultation with all Personnel involved in the Work. This includes but is not limited to toolbox meetings prior to the start of the Work, worksite HS meetings on a regular basis with all parties involved (including

Subcontractors, the Engineer and third parties). It may also comprise other forms of communication.

Contractor shall ensure that supervision, directly in charge of construction activities, fully brief and discuss with Personnel at HS Tool Box Talks at the start of each work day and prior to commencing new activities. These talks shall be conducted in a language understood by the workforce. A checklist shall be utilised for this purpose. At a minimum it shall include the following;

i. Nature of the job

ii. Associated hazards

iii. Safe working methods to be adopted

iv. Requirements of the Permit to Work

The Contractor shall convene weekly team talks, extended to Subcontractors if applicable.

219. SECURITY

The Contractor shall evaluate the security strategy and arrangements required for all worksites including transport. This evaluation shall be performed by qualified security experts and shall form the basis for the Worksite Security Strategy and Plan which shall be submitted and approved by the Engineer as part of the HSMP. The Security Strategy and Plan shall describe:

- Security risks and the identified mitigation / management measures
- Roles and responsibilities including details of the Contractor and Subcontractors
- Detection, monitoring and management procedures
- Escalation plans including resources

220. EQUIPMENT AND OPERATING STANDARDS

The facilities and equipment used by the Contractor are installed, maintained, revised, inspected and tested pursuant to the manufacturer's recommendations. The recommendations are available in the language of communication defined under GCC Sub-Clause 1.4 (or any other language approved by the Engineer).

221. WORK PERMIT

The Contractor puts in place a work permit procedure, prior to the starting of the works. The procedures define the approval process between the person qualified to issue the work permit and the personnel (or Subcontractors) carrying out the work.

Permits are issued in writing. Unless specified otherwise in the Contract, or instructed otherwise by the Engineer, works which require a work permit are defined in the health and safety plan. All other work permits required by the Engineer will be implemented by the Contractor.

222. PERSONAL PROTECTIVE EQUIPMENT

The Contractor ensures that all personnel, visitors or third parties entering a Project Area are equipped with Personal Protection Equipment (PPE) pursuant to the practices and standards specified in Clause 201.

Where appropriate, PPE must be worn by women as well as by men.

The Contractor describes in the HSMP the PPE to be used per Project Area and per activity.

Personnel and visitors to Project Areas are equipped with a safety helmet, safety shoes and a reflective jacket as a minimum.

Adequate quantities of PPE are available on the Project Areas. Storage conditions must be compatible with usage pursuant to the provisions of ESHS Specifications Clause 30.

Contractor personnel are trained in how to use and care for PPE and the Engineer has access to training certificates.

When handling acids, caustics, and chemicals with corrosive or toxic properties, suitable protection shall be worn to prevent accidental contact with the substance.

223. DANGEROUS SUBSTANCES

A substance is considered dangerous if one or several of its properties render it dangerous, as defined in sub-clause 245. The Contractor identifies and manages dangerous substances planned for use on the Project Area in the manner described in the present Clause.

The assessment of the impact of the toxicity of dangerous substances on the reproductive functions of women and men must be taken into account.

The transport to the Project Area and use of dangerous substances requires prior authorisation from the Engineer.

Details of risks and related prevention and protection measures are included in the health and safety plan.

The Contractor obtains all necessary authorisations and/or licenses for the storage and use of dangerous substances from local authorities. A copy of the authorisations is provided to the Engineer.

For each dangerous substance used, the Contractor will implement the recommendations described (i) in the Material Safety Data Sheets (MSDS), and (ii) by the Globally Harmonized System of Classification and Labelling of Chemicals established by the United Nations for hazardous chemicals.

Copies of MSDSs are kept on the Project Area, and made available to personnel. The Contractor provides the Engineer with copies of all MSDSs.

Storage of dangerous substances

i. Storage areas are designed and equipped by the Contractor based on the chemical and physical properties of the substances, on the types of containers stored, the number of people requiring access, the ventilation requirements, the quantities of the substance used and potential chemical reaction with other substances.
ii. Pursuant to sub-clause 209, the Contractor anticipates and plans for the storage and management of hazardous waste.
iii. Storage areas for dangerous substances are subject to strict rules, which are regularly checked by the ESHS manager. The rules include the following as a minimum:

- Access to the storage area is limited to trained and authorised individuals;
- An inventory is maintained up-to-date;
- MSDSs must be available for all stored dangerous substances, and the substances must be clearly labelled;

- A strict and methodical storage system is implemented (storage plan posted, large or heavy packaging may not be stored at heights, equipment and tools may not be stored in the dangerous substance storage room);
- Compliance with product expiry dates and implementation of a disposal procedure for substances which are not needed or which have expired;
- Entrances, exits and access to emergency equipment are kept clear at all times.

iv. Storage areas are clearly identified with warning signs at the entrance. The Contractor displays the storage plan (location of the different products, maximum inventory), a summary of labelling system and information on chemical incompatibilities.

v. Chemicals which could react together (leading to explosions, fire, projections or the emission of dangerous gases) are physically separated.

vi. Products that react violently with water are stored so as to prevent contact with water, even in the event of flooding.

vii. Inflammable products are stored separately in a dedicated area with adequate ventilation at all times.

viii. Buildings used to store large quantities of dangerous substances are isolated from other buildings to avoid the spreading of fire. Such buildings are constructed using solid and non-combustible building materials, and are equipped with evacuation systems and the appropriate firefighting equipment. Access to the buildings is clear, allowing for rapid evacuation in the event of an accident. The electrical systems are reduced to the essential minimum, and access points are equipped with adequate lighting (300 lux).

ix. All storage areas are equipped with secondary retentions. Each storage area acts as a general secondary retention. Suitable absorbents (neutralising and non-combustible) are available in the storage area to clean up any spills and leaks.

x. The Contractor maintains the storage area at a suitable temperature for dangerous substances to prevent overpressure and bursting of containers.

224. PLANNING FOR EMERGENCY SITUATIONS

The Contractor shall establish an emergency plan as a section of the ESMP. It covers the following emergency situations as a minimum:

i. e.g. Fire or explosion;

ii. e.g. Collapse of structures, or scaffolding;

iii. e.g. Loss of the containment of dangerous substances;

iv. e.g. Safety incident or malicious act.

The Contractor shall maintain fit-for-purpose Emergency Response Capability, which shall be clearly documented.

At a minimum, the Contractor shall make contingency arrangements for calling a Doctor and transporting injured persons to hospital. The telephone numbers of the emergency services and the name, address and telephone number of the Doctor and the nearest hospital shall be prominently displayed in the Contractor´s office.

The Contractor ensures that all personnel are informed and aware of how to react in an emergency situation, and responsibilities are defined. Information and awareness training is documented, and available on all Project Areas.

The Contractor organises and documents emergency simulation exercises within 3 months of the physical start of the works, and subsequently once every 12 months up to the issue of the Taking-Over Certificate. The Engineer is invited to participate in each of these exercises.

Fire protection

i. Based on a fire safety risk assessment, the Contractor will ensure that adequate and appropriate fire safety measures are in place to minimise the risk of injury or loss of life in the event of a fire. Appropriate actions include: Keeping sources of ignition and flammable substances apart; Avoiding accidental fires; Ensuring good housekeeping at all times, eg avoiding build-up of rubbish that could burn; Installing smoke alarms and fire alarms or bells; Installing fire warning systems; Having correct fire-fighting equipment; Keeping fire exits and escape routes clearly marked and unobstructed at all times; Ensuring workers receive appropriate training on procedures they need to follow, including fire drills.

ii. Fire will not be used as a method of forest or vegetation clearance.

iii. Fire extinguishers are made available in each building at clearly identified locations, and fires are strictly forbidden outside of the cooking area.

iv. If applicable, the Contractor makes arrangements with local fire-brigades for emergencies

225. MEDICAL CHECK-UPS

The Contractor organises medical check-ups carried out by a doctor or an appropriately qualified nurse for all Contractor's Personnel prior to the initial mobilisation to the Project Area to check aptitude for the work. Medical check-ups are adapted to the anticipated occupied positions and carried out pursuant to the recommendations of the International Labor Organization. Subsequent to the check-up, a written medical certificate is issued declaring the aptitude of the worker for the allocated tasks.

Hearing tests are conducted for the Contractor's personnel exposed to noise levels above 80 dB(A) in order to establish initial audiograms. Annual tests are carried out to monitor any changes and detect any deterioration.

The Engineer can request additional medical examinations for the Contractor's Personnel if considered necessary, all costs to be borne by the Contractor.

A medical examination is carried out on any Contractor's Personnel returning to work after leave caused by a workrelated accident. A written medical certificate is issued confirming the Contractor's Personnel's aptitude to return to work at the designated workstation.

The Contractor can produce a copy of its Contractor's Personnel's work aptitude certificates at the request of the Engineer or any competent authority.

Specific arrangements for tasks' assignments or workstations shall be made for pregnant Personnel.

226. FIRST-AID

The Contractor ensures a minimum of first-aid provisions on any work site, including: suitably stocked first-aid kits; a person, respectively an adequate number of staff appointed and trained to take charge of first-aid arrangements and ensure that staff and workers are informed about first-aid arrangements.

The Contractor equips the Project Area with a communication system exclusively for the purposes of communication with the first aid services. Information on how to communicate with the first aid services is **clearly** indicated near the communications equipment.

227. MEDICAL SERVICES AND PERSONNEL

The Employer will inform the Contractor about the presence and number of medical personnel in the Project Area. If not otherwise instructed by the Engineer, in application of clause GCC 6.7, the Contractor shall collaborate with local health authorities and make arrangement with an appropriate number of local doctors, and/or nurses, hospitals and ambulance services to ensure that medical staff, first aid facilities, sick bay and ambulance service are available at a minimum within 45 minutes at the Site, and at any accommodation for Contractor's and Employer's Personnel or if appropriate, be based in the Project Area. **HEALTH CARE CENTRE**

In absence of a health centre within the Project Area, the Contractor shall make contingency arrangement for transporting injured persons to a hospital.

i. For Project Areas with more than 35 workers present at any one time and where it is not possible to reach a hospital, medical clinic or a health center within a period of 45 minutes, by land and in normal conditions, the Contractor sets up a health care centre. The Contractor will do so at its own cost and ensure that the centre is:

- Operational and easy to access at all times;
- Kept clean and in good condition;
- Equipped with appropriate heating or air-conditioning;
- Equipped with sanitary facilities and drinking water;
- Equipped with instruments, equipment, medicines and material required to examine and treat injured or sick workers in emergency conditions;
- Equipped with the supplies and furnishing required to allow medical personnel to provide first aid and fulfil their other functions.

ii. A doctor is on-site at all times, working full-time during normal day-shift hours. The doctor is on-call when more than 20 workers are working simultaneously outside of normal day-shift hours.

iii. The doctor has the following profile:

- At least 5 years' experience on large-scale construction works at sites located at a distance from a hospital;
- Trained in infectious diseases, waterborne and epidemiological diseases prevalent in the Employer's country;
- Able to lead training sessions on occupational health and first aid;
- Trained in management and logistics for a remote health care centre;

- Able to speak the same working language used by most members of personnel fluently (communication in emergency situations);
- In good physical condition, able to access remote working areas.

229. EMERGENCY MEDICAL EVACUATIONS

The Contractor allocates rapid emergency transportation for first aid purposes to the first aid station pursuant to **standard** NF EN 1789:2007.

In cases where there is no first aid emergency vehicle available to evacuate severely ill or injured personnel, the Contractor establishes an agreement with a specialised company for the handling of personnel in **the** event of a serious accident requiring an emergency medical evacuation and ensures that transport is guaranteed any time and as fast as possible. The Contractor will provide a copy of the agreement to the Engineer within one month of the physical start of works.

The agreement includes a convention with a referring hospital where the member of personnel evacuated in **emergency** conditions will be treated.

In highly remote areas or in demonstrably life threatening cases, the agreement may cover the use of air transportation (**if** available) in order to evacuate the injured patient(s) to the referring hospital.

The telephone numbers of the emergency services and the name of the service providers and the doctors shall be prominently displayed in the Contractor´s site office

230. ACCESS TO HEALTH CARE AND TRAINING

The Contractor guarantees **access** to health care as defined in Clause 227 for all personnel in case of accident or illness occurring during the execution of the works, i.e.:

i. Medical check-ups: initial (recruitment), annual and upon returning to work after sick leave;

ii. Screening, vaccinations and preventive healthcare;

iii. General healthcare during the execution of the works;

iv. Medical assistance in the event of an accident and assistance for emergency evacuations.

Subcontractor's personnel, **other** contractors, the Employer or the Engineer, present at the Project Area, must never be refused medical assistance, under the pretext that they are not directly employed by the Contractor. The Contractor may however define a unit rate cost per medical act for personnel, other than its own Contractor's Personnel, display this rate in the healthcare centre and forward the information to the Engineer.

In the event of accident or serious illness, medical personnel must be trained, available and equipped with the necessary **material**, medicines and consumables to provide first aid for the patient, stabilise their condition, until the patient is:

a) Either treated or discharged; or

b) Hospitalized at the camp or in a larger hospital; or

c) Evacuated to a medical centre which is well equipped for intensive care, if necessary.

231. HEALTH MONITORING

The Contractor cannot recruit workers in poor health.

The initial pre-recruitment examination must confirm that applicants are physically able to carry out the tasks required for the position.

The detection of pregnancy during the initial pre-recruitment examination of female applicants shall not constitute grounds for declining recruitment, unless medical risk is proven.

The Contractor organises annual medical check-ups for its Contractor's Personnel and keeps up to date a medical record for each Contractor's Personnel. The presence of Contractor's Personnel for medical check-ups, treatment and hospitalisation is incorporated into the Contractors planning.

If applicable and as recommended by a doctor or instructed by the Engineer, the Contractor provides the Contractor's Personnel with prophylaxis and vaccinations against local diseases and vectors. In particular, the Contractor will promote the use of impregnated mosquito nets by its Contractor's Personnel in camps or offsite lodging, and distributes these nets appropriately.

The health and safety plan includes a Contractor's Personnel health risk assessment based on exposure to dangerous substances and describes the medical monitoring implemented.

232. SANITARY REPATRIATION

The Contractor is responsible for the sanitary repatriation of Contractor's Personnel in the event of a serious injury or illness, based on a diligent examination and a statement of the doctor in charge. The Contractor will take out the necessary insurance to cover the cost of the sanitary repatriation of its Contractor's Personnel.

233. HYGIENE, ACCOMMODATION AND FOOD

Drinking water

i. Pursuant to Sub-Clause 6.14 of the GCC, the Contractor provides personnel with drinking water at all Project Areas. The quantity and quality of this water complies with the standards of the World Health Organization at supply points.

ii. Unless the supply of drinking water is provided by a certified supplier, the quality of the drinking water provided to workers is tested at least at the start of the works and then on a monthly basis. The protocol for taking and analyzing samples is based on the recommendations of the World Health Organization. The results shall be documented and made available on the Project Areas.

Toilet Facilities on Work Sites

i. The contractor must make available adequate toilet and washroom facilities for the workforce at different convenient points on site.

ii. If no satisfactory, permanent options are available then the contractor must provide modern eco-mobile toilets, from a company approved by NEMA for use by the workforce.

Accommodation conditions

i. The accommodation provided for non-resident Personnel in a camp or an alternative structure outside of the Project Areas, such as a hotel or rented house, will comply with the conditions of the present Sub-Clause in pursuance of Sub-Clause 6.6 of the GCC.

ii. The person in charge of managing the accommodation has a specific duty to report to the ESHS manager or if existent, the HS manager, the outbreak of any contagious diseases, food poisoning and other important casualties. The ESHS Manager in turn will inform the appropriate health authorities.

iii. Rooms are lit and equipped with power sockets, beds and windows fitted with mosquito nets. Flooring is of a hard and impervious material.

iv. The temperature in rooms and common areas shall be kept at an appropriate level during occupied hours (20 degrees in moderate to cold zones and providing adequate ventilation in hot zones).

v. The Contractor provides one drinking water tap per 10 Contractor's Personnel, one shower per 10 Contractor's Personnel as a minimum, one individual toilet for 15 Contractor's Personnel as a minimum, and one urinal per 25 Contractor's Personnel at accommodation camps. Separate showers and toilets must be made available for women.

Hygiene in shared areas

i. Sanitary areas (showers, sinks, urinals, toilets) are cleaned and disinfected by the Contractor's cleaning service at least once every 24 hours. Cleaning operations are documented.

ii. The canteen, kitchen and kitchen utensils are cleaned after each meal service.

iii. The number and location of toilets on Project Areas shall be adapted to the number of employees and the configuration of the Project Areas (distance, isolated area, etc.). For urinals and toilets, usual standards are 1 unit to max15 persons.

iv. Toilet facilities are conveniently located and easily accessible. In addition, all toilet rooms shall be well-lit, have good ventilation or external windows, have sufficient hand wash basins and be conveniently located.

Food

i. In application of Sub-Clause 6.13 of the GCC and Sub-Clause 239 of the present specification, the Contractor provides meals at a reasonable cost or free of charge to its Contractor's Personnel per shift in a canteen area and according to a procurement system which complies with the provisions of this ESHS Specifications Sub-Clause.

ii. The Contractor defines and implements actions in order to guarantee (i) the quality and quantities of food stuffs, (ii) compliance with health rules when preparing meals, (iii) fitting out and servicing premises and equipment, both in the kitchen and food storage areas.

iii. The Contractor inspects the cleanliness of food transport vehicles, temperature control and the cold chain, as well as best-before dates, and takes the necessary corrective actions. The temperatures of chillers are regularly checked.

iv. The Contractor checks that health requirements are met for food storage conditions in the kitchen or other locations, food cooking times and temperatures, and the conditions in which prepared products are left prior to consumption, to ensure no health risks. Prepared food is eaten or thrown away, no food remains are reused.

v. The Contractor recruits trained canteen personnel and ensures that supervisors monitor compliance with sanitary instructions. The Contractor ensures that canteen personnel have means of ensuring compliance with health rules (changing rooms, linen, hand washers, the condition of flooring and paint, and the existence of a cleaning plan).

At the request of the Engineer, the doctor at the health centre specified in Clause 228 of the present ESHS Specifications, carries out an audit on all Project Areas every 3 months, and documents the results, and includes the conditions of hygiene in which meals are prepared and food conserved. The results of this audit are provided to the Engineer.

The Contractor, on the basis of the advice of the doctor at the health centre, informs Contractor's Personnel on appropriate behaviour in terms of workplace hygiene. The occasional distribution of information is not sufficient, the Contractor regularly reiterates the importance of hygiene, documents these reminders, and ensures that the information is understood, easy to apply and scrupulously complied with.

234. SUBSTANCE ABUSE

Pursuant to Sub-Clause 6.16 of the GCC, the use, possession, distribution or sale of illegal drugs, controlled substances (as per local regulations) and alcohol is totally prohibited on the Project Areas. The Contractor implements a zero tolerance policy for the consumption of these substances.

Any person suspected by the Engineer to be under the influence of alcohol or controlled substances on any Project Area is immediately suspended from his position by the Contractor, pending the results of medical tests.

235. LABOUR CONDITIONS

The Contractor shall ensure decent labour conditions for workers and notably compliance with applicable law and regulations in the country of implementation of the contract, and with the fundamental conventions of the International Labour Organisation (ILO). This includes workers' rights related to wages, working hours, rest and leave, overtime, minimum age, regular payment, compensation and benefits, equal opportunities, a non-discriminatory workplace, best practice on human resource management and occupational health and safety. Wages, benefits and conditions of work will be comparable to employers in the relevant region of that country/region and sector concerned.

The Contractor shall respect and facilitate workers' rights to organize and provide a Worker Grievance Mechanism for all workers, including the workers of subcontractors, shall receive an induction on their rights and on the Worker Grievance Mechanism. The Contractor will display the contact details of the Worker Grievance Mechanism at well visible places in all camps and work sides.

The Contractor shall issue and implement internal policies and procedures to assure that no employee or job applicant will be subject to discrimination and/or harassment.

The Contractor shall establish for their personnel and those of their main contractors a system to monitor hours worked on the Project and seek to identify and remedy any practices which lead to long working hours in excess of national legislation.

236. LOCAL RECRUITMENT

Local recruitment is defined as the number of positions actually allocated to people residing in the region of the Works (less than two hours by land transport to the Project Area) for more than one year and citizen of the Employer´s country.

Pursuant to Sub-Clause 6.1 of the GCC, the Contractor, and/or respectively the Subcontractor hiring local workers, must establish and initiate a local recruitment policy and a procurement plan to ensure that recruitment procurement procedures are transparent and disseminated to the project affected communities for the duration of the Works.

The policy and plan shall be enforced by the Subcontractors and suppliers of major supply items, responsible for hiring local workers.

The Contractor demonstrates the effective implementation of this policy to the Engineer in its monthly activity report.

Pursuant to Clause 8 of the present ESHS Specifications and if requested by the Employer, the Contractor develops a training programme aiming to support the local recruitment policy.

This training programme must be available to women and vulnerable groups and adjusted to their level of education.

An incentive mechanism to increase the share of women recruited by the Contractor and the Subcontractors may be established.

Local labour needs are estimated prior to the start of works and described in the ESMP with the following information:

a) Identification of positions that could be filled by local staff and the level of qualification required;

b) Definition of the planned procedure for the effective recruitment of these members of staff;

c) Establishment of mechanisms to ensure non-discrimination of women in accessing recruitment procedures;

d) Deployment schedule for these positions;

e) Initial training to be provided by the Contractor for each job description.

In order to prevent outsiders from entering the Project Area, local recruitment at the Project Area, including at the entrance, is prohibited.

Local recruitment office

i. One month prior to the start of Works, the Contractor establishes a local recruitment office in the district where the main Project Area is located, at a location pre-approved by the Engineer.

ii. A representative of the Contractor is present in this office at least two mornings each week, from the start of the works to a date pre-approved by the Engineer.

iii. The representative provides information on job vacancies with the Contractor for the execution of the works (required qualifications, duration, and location) and on the information to be provided in applications.

iv. Lists of local candidates are drafted by the representative allocated to the office and forwarded to the Contractor's Humans Resources manager on a weekly basis.

The Contractor's Human Resources manager selects candidates listed by the local recruitment office based on requirements for the Works and the Contractor's recruitment procedures. A written contract between the Contractor and the local Contractor's Personnel is drafted, signed and archived by the Contractor.

If the Project Areas are located near to several different communities, the Human Resources manager ensures a fair distribution of local recruitment between the different communities.

The Human Resources manager will ensure that recruitment campaigns in local communities have been spread to women and that the latter have not been discriminated in recruitments.

Pursuant to Sub-Clause 6.22 of the GCC, the Contractor maintains one record per local Contractor's Personnel indicating the hours worked per person allocated to the works, the type of tasks carried out, the wages paid and any training provided. Records are available at the main Project Area at all times, so the Engineer and the authorised representatives of the government can assess the content.

237. TRANSPORT

Unless specified otherwise in the Contract, or instructed otherwise by the Engineer, the Contractor provides or enables access to daily transport for Contractor's Personnel not housed in the camps managed by the Contractor and living more than 15 minutes' walk from the Project Area and less than one hour by land transport.

The transport is organised under conditions which comply with local regulations and which ensure the safety of the people transported.

The Contractor organises collective transport: pick-up times and locations are defined and services organised appropriately.

Transport from the living facilities to his wages worksite is safe and free. If the Project Area is moved during the working season and if the Contractor retains the local personnel trained at the start of the works, the accommodation of the Contractor's Personnel is managed by the Contractor:

a) Within a mobile camp with the other non-local Contractor's Personnel; or

b) In villages located near to the mobile Project Area, in this case, each local Contractor's Personnel will receive a housing allowance in addition areas within each camp and a sports field for use by Personnel.

238. WORKERS´ ACCOMMODATION

Living facilities are located to avoid flooding and other natural hazards.

Where possible, living facilities are located within a reasonable distance from the worksite.

The living facilities are built with adequate materials, the sites are adequately drained to avoid the accumulation of stagnant water, kept in good repair and kept clean and free from rubbish and other refuse.

Rooms shall not be mixed: separate rooms must be made available for both men and women.

Separate toilets and locker rooms shall be provided for women and men.

The Contractor constructs and maintains a range of recreational facilities and shared leisure

The Contractor ensures that at campsites:

a) Workers have access to an adequate and convenient supply of free potable water,

b) that drinking water meets national/local or WHO drinking water standards,

c) that all tanks used for the storage of drinking water are constructed and covered as to prevent water stored therein from becoming polluted or contaminated,

d) that drinking water quality is regularly monitored.

Dormitories:

A separate bed for each worker is provided. The practice of "hot-bedding" shall be avoided. Rooms shall not host more than 8 individuals.

a) There is a minimum space between beds of 1 metre.

b) Double deck bunks are not advisable for fire safety and hygiene reasons, and their use is minimised. Where they are used, there must be enough clear space between the lower and upper bunk of the bed. Standards range from to 0.7 to 1.10 metres.

c) Triple deck bunks are prohibited.

d) Each worker is provided with a comfortable mattress, pillow, cover and clean bedding.

e) Bed linen is washed frequently and applied with repellents and disinfectants where conditions warrant (malaria).

f) Facilities for the storage of personal belongings for workers are provided, including 0,5 m^3 and 1 meter of shelf unit.

The Contractor shall mitigate impacts of activities (e.g. those that create noise or light) at worksites in order to avoid any public disturbance or disturbance of camp residents.

239. MEALS

Food supplies for the meals of the Contractor personnel will exclude any meat obtained from hunting or poaching, with the exception of fish.

The Contractor provides for at least two meals per shift to local Contractor's Personnel pursuant to the hygiene conditions specified in Clause 40 of the present ESHS Specifications, at reasonable price for the Contractor's Personnel. If no canteen is available, the Contractor at least pays for a minimum of 2 meals per day per shift.

The Contractor shall avoid any local disputes through respecting local culture and values. The Contractor shall ensure that workers are aware of local issues and sensitivities, and respect local culture and values in order to avoid any local disputes and crime.

240. COMMUNITY INTERACTION

Commensurate with the size of Construction activities and unsolved potential disturbances of the community and risks to public health and safety, the Contractor shall produce an Implementation Plan related to Community Interaction and submit it to the Engineer for review and acceptance prior the commencement of any works or traffic related to works.

The plan shall include a schedule of planned work activities which may impact a neighboring community and describe (i) the activities per task and phase which may impact the neighboring communities (ii) the approach to engage and communicate with stakeholders related to the works defined in (i); (iii) responsibilities for community interaction per task and phase.

When meeting stakeholders in neighboring communities, minutes of meetings shall be produced and recorded as by Employer's guidelines;

The Contractor shall disclose relevant information related to the involved impacts and risks to communities (e.g. related to Traffic Management or e.g. to entering of private property for surveys) in local language and at a level of complexity that is commensurate with local realities to ensure that stakeholders fully understand the content.

The Contractor shall include information about the Employer´s grievance mechanism and the contact details in all community communication materials.

241. DAMAGE TO PEOPLE AND PROPERTY

The Contractor shall implement a worker´s Code of Conduct and not disturb or interfere with the inhabitants of local communities close to or in the Project Area, and shall respect their houses, cultures, animals, properties, customs and practices.

The Contractor`s personnel shall be trained to understand the requirements about use of unapproved land and the need to stay strictly within site boundaries and within the working areas, using only approved access and service roads.

Pursuant to Clauses 4.14 and 17.1 of the GCC, the Contractor is responsible for damages to people and property caused by the execution of the works or the procedures used for execution (e.g. project vehicles demolishing local fences or houses, driving accidentally over crops or causing any other material grievances).

Access to the Project Areas is prohibited to unauthorized persons. The Contractor is responsible for the security and access control of the Project Areas.

The Engineer is informed of any damage caused to people, or the property of individuals, other than the Contractor's personnel, within 6 hours of the event, regardless of the value of the prejudice.

The Contractor shall establish procedures to manage and rectify and record incidents related to community disturbances.

Blasting

i. Housing existing before the start of the works, located within a minimum radius of 800 m around the perimeter of the quarries and within a minimum radius of 500 m around the other Project Areas that will be subject to blasting, will be examined by a bailiff unless agreed upon otherwise with the Engineer.

ii. The bailiff's sworn statement is prepared and provided to the Engineer with the Site Environmental Protection Plan.

iii. Should any problems be detected due to the intensity of blasting, the Engineer is entitled to request that the Contractor carry out seismic measurements of the intensity of the vibrations induced by the blasting, at variable distances from the blasting points, under the supervision of the Engineer, and at the cost of the Contractor.

242. LAND ACQUISITION AND LAND TAKE

Pursuant to Sub-Clause 7.8 of the GCC, the Contractor will cover (i) occupancy indemnities for the extraction or use of construction materials and (ii) the cost of acquiring the necessary land to stockpile excess backfill material.

The Contractor provides compensation for any prejudice suffered by the owners of the land mentioned in the previous Sub-Clause, but also for any prejudice incurred by users of this land, if these users are not the same parties as the owners.

If not otherwise instructed by the Employer, the Contractor demonstrates to the Engineer (i) who are the owner and the users, if different parties have been identified, and (ii) a written agreement governing the temporary occupancy or acquisition of this land has been negotiated and duly paid up to the two parties, if different.

243. TRAFFIC MANAGEMENT

The Contractor defines the characteristics of its fleet of vehicles and site machinery in the ESMP, in the form of a traffic management plan with the aim to prevent construction site vehicle incidents by the effective management of transport operations throughout the construction process.

The Contractor defines in the traffic management plan the itineraries used on a map for each route between the different Project Areas and for each phase of the construction works, and obtains the validation of the Engineer. The Contractor requests that the Employer obtain the authorisations of the competent administrative authorities if public roads are used. Any Engineer’s instruction to update the traffic management plan shall be implemented.

The Contractor defines in the traffic management plan the itineraries used on a map for each route between the different Project Areas and for each phase of the construction works, and obtains the validation of the Engineer. The Contractor requests that the Employer obtain the authorisations of the competent administrative authorities if public roads are used. Any Engineer’s instruction to update the traffic management plan shall be implemented.

To reduce accidents, the Contractor will ensure that:

a) Pedestrians and vehicles are kept apart (e.g. through providing separate entrances, walkways, signals)

b) Vehicle movements are minimized

c) Drivers are adequately trained and have the appropriate permits for driving vehicles

d) Turning circles for turning vehicles are installed.

Within one month of the physical start of works, the Contractor informs the administrative authorities of areas crossed by the Contractor’s vehicles, of the itinerary and characteristics (frequency of passing, size and weight of trucks, materials carried) of the Contractor's fleet of vehicles.

If public roads are used, and unless approved otherwise by the Engineer, the Contractor mandates a bailiff to make a sworn report regarding the state of the road prior to use by the Contractor's vehicles. The report is annexed to the ESMP.

The Contractor describes in the traffic management plan the expected traffic created by its fleet of vehicles (frequency of trips between Project Areas, working hours, convoys).

The Contractor also describes the number and positioning of flagmen.

Unless specified otherwise in the Contract or instructed otherwise by the Engineer, heavy vehicles (i.e. with a GVWR of more than 3.5 tons) may not be used at night between 22:00 and 06:00.

Speed limits

i. The Contractor takes action to limit and check the speed of all vehicles and machinery used to execute the works at an appropriate level.

ii. The maximum speed of all machinery and vehicles of the Contractor comply with the lowest of the following: the speed limit defined according to the Employer's country regulations or the following limits.

iii. 20 km/h within the Project Areas;

iv. 30 km/h in villages or hamlets, in towns, from 100m before the first house;

v. 80 km/h on unpaved roads outside of towns, villages, hamlets and camps.

vi. Pursuant to Sub-Clause 4.15 of the GCC, and in coordination with the competent Employer's country authorities, the Contractor provides and installs signs for the fleet of vehicles along public roads, when public signs are inadequate.

vii. The Contractor provides each of its drivers with a map at the appropriate scale of the roads authorised for the execution of the works, clearly indicating the maximum speeds authorised, and ensures their understanding.

It is strictly prohibited to transport people, equipment or products other than those required for the Works and the management of Project Areas, on board any of the Contractor's vehicles. This provision also applies to the transport of live animals and meat obtained from hunting, fishing or poaching.

The trailers and skips used to carry materials which could be projected (sand, crushed material, aggregates, selected materials) are covered with a tarpaulin for the entire itinerary between two Project Areas.

244. FOSSILS/ ARCHAEOLOGICAL CHANCE FINDS

The Contractor shall establish specific procedures to manage the protection of archaeological and historical sites, chance finds and fossils as stipulated in Sub-Clause 4.24 of GCC.

245. PROPERTIES RENDERING A PRODUCT DANGEROUS

1.	**Explosive**	substances and preparations which could explode in the presence of a flame or which are more sensitive to impacts and friction than dinitrobenzene.
2.	**Combustive**	substances and preparations which, when in contact with other substances, particularly inflammable substances, undergo strongly exothermic reactions.
3.	**Easily inflammable**	substances and preparations (i) in liquid phase (including extremely inflammable liquids), with a flash point below 21°C, or which can heat up to the extent of spontaneous combustion in ambient air; or (ii) in solid phase, which can burst into flames easily in the brief presence of a source of inflammation and which will continue to burn after the removal of the

		source of inflammation or (iii) in gaseous phase, which are inflammable in air at normal pressure; or (iv) – which, when in contact with moist air or water, produce dangerous quantities of gases which are easily inflammable.
4.	**Inflammable**	liquid substances and preparations, with a flash point equal to or above 21°C and less than or equal to 55°C.
5.	**Irritant**	non-corrosive substances and preparations which, when in immediate, extended or repeated contact with the skin and mucosa, can cause inflammation.
6.	**Harmful**	substances and preparations which, in case of inhaling, swallowing or cutaneous penetration, can lead to risks of limited severity.
7.	**Toxic**	substances and preparations (including highly toxic substances and preparations), which, in case of inhaling, swallowing or cutaneous penetration, can lead to serious, acute or chronic risks, and even death.
8.	**Carcinogenic**	substances and preparations which, in case of inhaling, swallowing or cutaneous penetration, can lead to or increase the frequency of cancer.
9.	**Corrosive**	substances and preparations which, in case of contact with living tissues, can destroy the latter.
10.	**Infectious**	substances containing viable micro-organisms or their toxins, for which it is known or we have good reasons to believe that they cause disease in humans or other living organisms.
11.	**Harmful to reproduction function**	substances and preparations which, in case of inhaling, swallowing or cutaneous penetration, can induce or increase the frequency of undesirable non-hereditary effects in offspring or have a negative effect on reproductive functions and abilities.
12.	**Mutagenic**	substances and preparations which, in case of inhaling, swallowing or cutaneous penetration, can lead to hereditary genetic disorders or increase the frequency of these disorders.
13.	**React with water**	substances and preparations which, in case of contact with water, air or an acid, release a toxic or highly toxic gas.
14.	**Sensitivising**	substances and preparations which, in case of inhaling or cutaneous penetration, can lead to a hypersensitation, so that renewed exposure to the substance or preparation will cause characteristic harmful effects. This property can only be considered if test methods are available.
15.	**Ecotoxic**	substances and preparations with inherent or potential immediate or deferred risks for one or several environmental components.
16.	**Dangerous for the environment**	substances and preparations which are likely, after elimination, to lead to another substance, by any means, e.g. a lixiviation product, with one of the above characteristics.

3. CLEARING SITE

301. CLEARING SITE

The Contractor shall demolish, break up and remove buildings, walls, gates, fences, advertisements and other structures and obstructions, grub up and remove trees, hedges, bushes and shrubs and clear the site of the works at such time and to the extent required by the Engineer but not otherwise, subject to the provisions of Clause 4.24 of the Conditions of Contract: the materials so obtained shall so far as suitable be reserved and stacked for further use; all rubbish and materials for use shall be destroyed or removed from the site, as directed by the Engineer.

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

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

302. VEGETATION

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

303. BUSHES AND SMALL TREES

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

304. HEDGES

Where directed by the Engineer, hedges shall be uprooted and disposed off by burning.

305. FELLING TREES

Where shown on the drawings or directed by the Engineer, trees shall be uprooted or cut down as near to ground level as is possible. The rates entered in the Bill of Quantities shall include for cutting down, removing branches and foliage, cutting useful timber into suitable lengths, loading, transporting not more than 1 km. and stacking or disposing off all as directed by the Engineer.

For the purpose of measurement trees cut down shall be classified according to their girth at 1 metre above ground level, the cost of grubbing up roots shall be deemed to be covered by the rate for felling trees.

306. GRUBBING-UP ROOTS

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

be classified according to the mean diameter of the stump measured across the cut.

307. WEED CONTROL

The Contractor shall take all necessary precautions against the growth on the site of weeds and remove them as necessary throughout the period of works and maintenance.

The finished base of all footways and elsewhere as directed shall be sprayed with an approved persistent total herbicide at the rate recommended by the manufacturer. The application shall be by an even spray in a high volume of water at about 0.7 to 0.11 litres per square metre. After this application the footways shall receive at least two further waterings before the surface is sealed.

4. EXCAVATION

401. DEFINITION AND CLASSIFICATION OF EXCAVATED MATERIALS

Excavation in the Bills of Quantities shall be classified in two categories:-

1) Common Excavation
Any material which in the opinion of the Engineer can be excavated by use of pick axes and hand levers shall be classified as common excavation. Water logged material shall be included in this class. Murram in any form shall be classified as common excavation.

2) Rock
The decision of the Engineer in classifying rock shall be final and binding. Rock will be itemised in three classes:-

Class 'A'
Soft rock of the type known locally as 'tuff' which in the opinion of the Engineer cannot be considered as hard rock but which considerably increases the amount of labour needed for its removal shall be known as Class 'A' rock.

Class 'B'
Very weathered phonolite lava containing many fissures and faults shall be known as hard rock. This type of rock contains stones and boulders of unweathered or incompletely formed blacktrap or lava. A boulder or outcrop of hard rock 1.5 cubic metres or less and grey or green building stone in a formation which is massive and geologically homogeneous, will be deemed to be Class 'B' rock.

Class 'C'
Phonolite in a formation which is massive and geologically homogeneous shall be known as Class 'C' rock.

402. STORAGE AND HANDLING OF EXPLOSIVES AND BLASTING

The removal of hard materials by use of explosives will normally be permitted subject to compliance by the Contractor in all respects with the Explosives Laws of Kenya.

In the Bill of Quantities hard material is classified as rock where blasting will be permitted subject to this clause.

The Contractor shall provide proper buildings or magazines in suitable positions for the storage of explosives in manner and quantities to be approved; he shall also be responsible for the prevention of any unauthorised issue or improper use of any explosives brought on the works and shall employ only licensed and responsible men to handle explosives for the purpose of the works.

The shots shall be properly loaded and tamped and where necessary, the Contractor shall use heavy mesh blasting nets. Blasting shall be restricted to such periods and such parts of the works as the Engineer may prescribe. If, in the opinion of the Engineer, blasting would be dangerous to persons or property or to any finished work or is being carried out in a reckless manner, he may prohibit it, and order the rock to be excavated by other means and payment will be made at the

rate for rock for excavation where blasting is permitted. The use of explosives by the Contractor in large blasts, as in seams, drifts, pits, or large holes, is prohibited unless authorized in writing by the Engineer. In the event of wasting of rock through any such blasting, the Contractor shall if required by the Engineer, furnish an equivalent amount of approved materials for fill, 1 cubic metre of rock in-situ being taken to equal 1.5 cubic metre of material in embankment.

403. EXCAVATION FOR FILL

Where excavation reveals a combination of suitable and unsuitable materials, the Contractor shall, wherever the Engineer considers it practicable, carry out the excavation in such a manner that the suitable materials are placed separately for use in the works without contamination by the unsuitable materials.

If any suitable material excavated from within the site is, with the agreement of the Engineer, taken by the Contractor for his use, sufficient suitable filling material to occupy after specified compaction, a volume corresponding to that which the excavated material occupied, shall, unless otherwise directed by the Engineer be provided by the Contractor from his own sources.

No excavated material shall be dumped or run to spoil except on the direction or with the permission of the Engineer who may require material which is unsuitable to be retained on site. Material used for haul roads shall not be re-used without the permission of the Engineer.

404. COMPACTION OF FILL

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

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

Nevertheless, if with any material the Engineer doubts whether compaction will be obtained within the above moisture limits he may require compaction to proceed only when the limits of moisture content for the compaction of non-plastic materials are within the range of the optimum moisture content and 3 per cent below the optimum moisture content as determined by the laboratory compaction test method described in British Standard 1377: Methods of Test for Soil Classification and Compaction.

If any such non-plastic material on excavation is too wet for satisfactory compaction and the Engineer orders the moisture content to be lowered or raised, such work shall be treated as included in the rates. All adjustments of moisture content shall be carried out in such a way that the specified moisture content remains uniform throughout compaction.
Work shall be continued until a state of compaction is reached throughout the fill, which shall have relative compaction determined according to B.S. 1377 not less than 95% of maximum dry density at optimum moisture contents. For excavation under Roads, House Drives and Car Parks the backfilling shall be compacted in 150mm layers to 100% maximum dry density.

If with non-plastic materials the compacted material has become drier in the interval between the completion of compaction and the measurement of the state of compaction, then the moisture

content to be used for the calculation of the air content shall be the mean moisture content for the compaction of such materials as specified above.

405. EMBANKMENTS OVER SEWERS

In carrying embankments over sewer pipes, care shall be taken by the Contractor to have the embankments brought up equally on both sides and over the top of any such structures. Earth embankments shall be formed and compacted in layers of 200mm as the Engineer may direct. The filling immediately adjacent to structures shall be deposited and compacted in accordance with the drawings and approved by the Engineer. The cost of these works shall be included in the prices entered in the Bill of Quantities for the excavations from which embankments are formed.

406. FORMING BANKS AND FILLED AREAS

Banks and filled areas shall be made and built up to the levels, dimensions and shapes as shown on the drawings or as may be subsequently directed by the Engineer.

Before any filling is started, the ground on which the fill is to be placed shall be stripped of all grass and topsoil and all roots, vegetable matter and other unsuitable substances removed.

The filling to be used in the embankments and filled areas shall be material selected by the Contractor and approved by the Engineer from that arising from surplus excavation, the material being placed according to its nature as shall be directed, that is, coarse hard material may be placed at the bottom with the fine materials and/or soil placed at the top or at the surface. The Contractor may import materials if the available material is not sufficient.

The fill shall be placed in layers not exceeding 150 mm thick, each layer being thoroughly compacted by an approved roller to the satisfaction of the Engineer.

407. STONE REVETMENTS (STONE PITCHING)

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

408. TIPPED REFUSE ON SITE

Tipped refuse other than artificial deposits of industrial waste or shale found on the site shall be removed and disposed off in a spoil heap to be provided by the Contractor.

409. REMOVAL OF INDUSTRIAL WASTE, ETC.

Artificial deposits of industrial waste or shale found on the site shall be removed and disposed off as directed by the Engineer. Should any particular deposits consist of or contain material which in the opinion of the Engineer is suitable for incorporation in fills, all such material shall be used accordingly and deposited in layers and compacted as specified. The prices entered in the Bill of Quantities for the excavation of the material shall include loading, transportation, disposal and compaction of same as and where directed.

410. LAND SLIPS

Remedial works and/or the removal of materials in slips, slides or subsidences and overbreaks of rock extending beyond the lines and slopes, or below the levels shown on the drawings or required by the Engineer, will not be paid for.

411. CLASSIFICATION OF MATERIAL FROM SLIPS

The classification of material from slips or slides will be in accordance with its condition at the time of removal, regardless of prior condition. Measurement of overbreak in rock excavation shall be that of the space originally occupied by the material before the slide occurred and regardless of its subsequent classification.

412. BORROW PITS

Where for any reason, it becomes necessary to form borrow pits, these shall be located and the work executed in all respects to the instructions of the Engineer. They shall be regular in width and shape and admit of ready and accurate measurement, and shall be properly graded and drained and finished with neatly trimmed slopes.

413. RESTORATION OF BORROW AREAS, SPOIL TIPS AND QUARRIES

Any spoil tips, quarries or other borrow areas developed by the Contractor for the purpose of the Works shall be finished to safe and fair slopes to the approval of the Engineer. Where directed by the Engineer these areas shall be re-soiled and grassed over or otherwise seeded.

Operations of such borrow areas and tips shall be in accordance with the rules and regulations of the appropriate authority or the owner responsible for them.

414. STREAMS, WATERCOURSES AND DITCHES

Excavations carried out in the permanent diversion, enlargement, deepening, or straightening of streams, watercourses, or ditches shall be performed as directed by the Engineer. The rates for such excavations shall include for excavated materials and all pumping, timbering works, and materials necessary for dealing with the flow of water.

415. FILLING OLD WATERCOURSES

Where watercourses have to be diverted from the sites of embankments or other works, the original channels shall be cleared of all vegetable growths and soft deposits and carefully filled in with approved materials deposited and compacted as directed by the Engineer.

416. OPEN DITCHES

Open ditches for drainage purposes shall be cut where and of such cross section as the Engineer shall direct and where so required by him they shall be constructed before the cuttings are opened or the embankments begin. The sides shall be dressed fair throughout and the bottom accurately graded so as to carry off the water to the outlet to be provided. The material excavated from the ditches shall be disposed of as directed by the Engineer.

417. CLEARING EXISTING DITCHES

Where directed by the Engineer, existing ditches shall be cleared by removing vegetable growths and deposits. The sides shall be shaped fair throughout and the bottoms properly graded. Material removed from existing ditches shall be disposed of in tips provided by the Contractor. The rates

included in the Bill of Quantities for clearing ditches shall include for maintaining and keeping clean until and up to maintenance period.

418. EXCAVATION FOR FOUNDATIONS BELOW OPEN WATER

The rates for excavation for foundations below the water level shall include for the cost of all temporary close timbering and shoring, sheet piling, coffer dams, caissons, pumps and other special appliances required and for the draining of any water in the excavation.

419. TRENCHES OF GREATER WIDTH AND DEPTH THAN NECESSARY

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

420. SUPPORTS FOR TRENCHES

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

421. PROVISION OF SPOIL HEAPS

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

422. USE OF VIBRATORY COMPACTION PLANT

Where vibratory rollers or other vibratory compaction plant is used, the mechanism for vibration shall be kept working continuously during compaction operations, except during periods when the Engineer permits or directs discontinuance of vibration.

Unless otherwise permitted by the Engineer, the frequency for vibration shall be maintained within the range of amplitude and frequency recommended by the manufacturers of the plant for the material to be compacted. The frequency shall be recorded by a tacheometer indicating speed of rotation of any shaft producing vibrations.

423. WATER IN EXCAVATIONS

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

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

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

5. PIPELINE CONSTRUCTION WORKS

501. HANDLING OF PIPES AND FITTINGS

The Contractor shall exercise care in the handling of all pipes, specials, valves etc., to prevent damage to the structure surfaces and to the ends of the pipes.

502. TRANSPORTATION, HANDLING AND STORAGE

502.1. Packing for Transport

Pipes up to DN 300 may be bundled. Larger sizes shall be packed loose. Nesting of pipes is not permitted.

Containerised packing and transportation is also acceptable and if proposed shall be so indicated by the Bidder. All nuts, bolts, rubber gaskets etc. shall be packed in wooden boxes and protected against the elements.

Fittings up to and including DN 200 mm and flanged pipe pieces up to DN 200 mm and length not exceeding 1 metre shall also be packed and supplied in wooden boxes. All other fittings and flanged pipes may be packed loose. All flanges shall be protected with discs of wood, wool, fibre or timber. Bolted gland joints and flexible couplings shall be bundled if not containerised. Pipe sockets, spigots, plain ends shall be protected by suitable wrapping prior to transportation.

502.2. Loading and Unloading

Normally loading and unloading of small diameter pipes and fittings can be undertaken by hand; where mechanical means are used care should be exercised to ensure that the handling methods do not damage the pipes and fittings.

502.3. Storage Areas and Pipe Stacking

The Contractor shall comply with the manufacturer's specification regarding the storage of pipes, fittings and valves. Where storage dumps are to be provided along the route of the pipeline, these will be subject to the Engineer's approval.

All pipes, valves and fittings shall be inspected upon arrival at the pipe storage areas for damage to:

a) the pipe or fitting itself;
b) external coatings (if any);
c) internal linings (if any); and
d) jointing surfaces (incl. sockets if any).

The Contractor shall repair or replace defective pipes and fittings, at the Engineer's option. All expenses in connection with such remedial works or replacements shall be deemed covered by the Contractor.

The Contractor shall provide storage of pipes in a manner and in facilities approved by the Engineer. At the latter's discretion, ferrous pipes in diameters greater than 200 mm for laying in rural and peri-urban areas may be offloaded directly in the vicinity of the pipe trench.

Pipes shall be stacked at the pipe storage areas using one or all of the following methods.

a) square stacking for small diameter pipes;
b) parallel stacking using wooden roller boards; and
c) pyramidal stacking.

All pipes shall be stacked on raised wooden battens at least 100 mm thick and 225 mm wide. A minimum of three battens per pipe for ferrous pipe lengths not exceeding 6 metres should be used with the outer battens laid 600 mm in from both pipe end and the middle batten placed equidistant between them. For ferrous pipe lengths greater than 6 metres, four battens shall be used. Pipe stacks shall be suitably wedged and the Contractor shall be deemed to have included for an adequate number of timber, wedges, etc., in his Bid.

Where socket and spigot pipes are stacked, the sockets should be placed at alternate ends of the stack with the sockets protruding.

502.4. Distribution of Pipes from Storage

Ferrous pipes of ND 200 mm and less may be distributed from storage to the trench side no more than 7 days prior to laying whilst ferrous pipes above ND 200 mm may be strung out up to 15 days prior to laying.

In all instances when along trench sides, ferrous pipes shall be supported within 1 metre of either end on sand filled bags such that no part of the wall of the pipe touches the ground, and in the case of pipes over 6 metres long with additional central sand bags.

When pipes are being loaded into vehicles care shall be taken to avoid their coming into contact with any sharp corners such as cope irons, loose nail heads, etc. Whilst in transit, pipes shall be well secured over their entire length and not allowed to project unsecured over the tailboard of the lorry.

Pipes may not be offloaded from lorries by rolling them. Pipes shall not be rolled or dragged along the ground.

503. INTERFERENCE WITH FENCES, DRAINS AND OTHER SERVICES

The Contractor shall ensure the proper reinstatement of fences, drains, telephone lines, KP&L cables etc. where affected by his work. All services shall be adequately protected and propped to the satisfaction of the Engineer. The Contractor shall be liable for any damage caused to the services due to his failure to provide adequate protection.

504. METHOD OF EXCAVATION

The Contractor is deemed to have covered in his rates all the work that is necessary in order to comply with the provisions of the Specifications in general and this Clause in particular.

a) All trench excavation will, as a minimum precaution, be taped off to alert persons to its existence
b) For trenchworks the Contractor shall fix Sight Rails for use with boning rods at intervals of not more than 30 metres and temporary Bench Marks related to the

Survey of Kenya Datum shall be provided at such intervals as directed by the Engineer.

c) Excavations shall be made in open cut unless tunnelling or heading is specified by the Engineer or road authority

d) Where the trench passes through grassland, arable land or gardens, whether enclosed or otherwise, the turf, if any, shall be carefully pared off and stacked, and the productive soil shall be carefully removed for a width of 600mm greater than the nominated trench width, or equal to the overall width of track of excavating machine, whichever is greater, and laid aside to be subsequently used in reinstating the surface of the ground after the trench has been refilled.

e) The maximum length of open excavation shall not exceed 100 metres, except with prior written approval of the Engineer.

f) The Contractor shall excavate the pipe trenches in the line and to the depths indicated on drawings or as indicated by the Engineer. Except where otherwise indicated on the drawings or directed by the Engineer, it is intended that the trench shall be excavated to such a depth as will allow of a minimum cover over the top of the barrel of the pipe when laid as follows:

- Under roads and trafficked areas – 1.2m
- Other areas – 0.9m

g) Lesser trench widths may only be authorised if the Contractor can prove to the satisfaction of the Engineer that he can consistently achieve the required compaction for a lesser width.

h) The Contractor shall, wherever necessary, by means of timbering or otherwise, support the sides of the trench so as to make them thoroughly secure, and afford adequate support to adjoining roads, land, buildings and property, during the whole time the trench remains open and shall remove such timbering when the trench has been backfilled. The cost of such timbering or other work shall be deemed to be included in the rates for excavation. In case the Contractor is instructed by the Engineer to leave any portion of such timber in position after backfilling the trench, he will be paid for it accordingly.

i) The clear width inside the timbering shall be at least 150mm in excess of the external diameter of the pipe being laid, in order to allow it to be freely lowered into position, in the trench without damage to the external protection.

j) For pipes bedded in concrete sections, the breadth of concrete bedding for the pipes will be equal to the width of the trench. Excavation for valve chambers or any other water works structure, shall be carried out to the levels and outlines of such structures.

k) Where pipes are not laid on concrete, the bottoms of the trenches as excavated, shall be smooth and shall be free from stones or other projections. Holes cut out at pipe joints shall be as small as possible. The trench shall be dug to within 150 mm of its formation and proper grade pegs shall then be set in the bottom of the trench by the Contractor for the accurate taking out of the rest of the excavation. Grooves about 50 mm deep shall be cut across the trench at the required positions to enable the easy removal of pipe slings.

l) Where rock or large stones are encountered, they shall be cut down to a depth of at least 100mm below the level at which the bottoms of the barrel of the pipes or

flanges are to be laid, and covered to a like depth with fine material, so as to form a fine and even bed for the pipes. The bedding shall consist of soil which can be properly compacted to provide support for the pipe and to comply with Clause 509 b).

m) Where the soil at the formation level is not suitable for pipe laying, and if instructed to do so by the Engineer, the pipe trench shall be excavated to a depth of 100 mm below the invert of the pipe and be refilled with either a suitable 'as-dug' material or imported material.

n) The pipe trench shall be kept clear of water at all times and the Contractor should include the cost of this in his rates and consider this in his planning, e.g. due to the rainy seasons or work alongside water bodies or areas prone to flooding.

o) Should the Contractor excavate to a greater depth than is specified the bottom shall be made good to the correct level with Class 15/20 concrete or other material approved by the Engineer. No payment shall be made for any over excavation carried out by the Contractor nor for the cost of filling up to required levels.

p) The materials excavated must not be placed so close to the edge of the trench as to impose a risk of collapse of the trench walls. The excavation and trenching section of the site-specific Health and Safety Management Plan should include criteria for the allowable conditions for placement of trench spoils, as well as maximum trench depths and side slopes of unsupported trenches, requirements for trench shoring, and restrictions on personnel working in unsupported trenches.

q) During excavation, the Contractor shall ensure that all material suitable for re-use is kept separate and set aside and protected as necessary to prevent loss or deterioration. Materials forming the surface and foundations of roads shall when excavated and if required for further use, be carefully separated. Paving slabs, bricks and similar surfaces shall be carefully removed and stacked for re• use, or as otherwise instructed by the Engineer.

r) Where pipes are to be laid under a road formation or in open country, or in cutting, trenches shall generally be excavated after the earthwork is completed. The Engineer may permit these pipe trenches to be excavated before the earthwork is complete, but payment for the excavation of the trench will only be made upon the volume excavated below the road formation.

s) Trenches shall be bottomed up immediately in advance of pipe laying, although at least 15 metres shall be prepared in advance of any given pipe.

t) If in the opinion of the Engineer delays in laying are due to the fault of the Contractor and the ground becomes weathered prior to the laying of the pipes, the Contractor shall remove the weathered soil and replace it with suitable compacted material to the original formation level at his own expense.

u) For all excavation in rock the Contractor must obtain the prior agreement of the amounts with the Engineer, otherwise any claims for excavation in rock will not be considered!

v) With the written approval of the Engineer, the Contractor may excavate rock in advance and temporarily refill the trench with the excavated material until he is ready to proceed with the laying of the pipe.

w) Where the trench is in rock or rocky ground the Contractor shall excavate the pipe trench to a depth of 150 mm below the invert of the pipe and refill

with compacted granular fill. The Contractor shall obtain the Engineer's approval and instruction as to which sections of trench should be so treated.

x) Rock in the form of boulders predominantly above ground level and located within 1 metre of the centre line of the pipeline shall be removed, if required by the Engineer, who shall determine in each case whether the removal of the boulder is necessary to achieve the required alignment or profile or to ensure the future safety of the pipeline.

y) Where trench excavation is carried out behind existing thrust blocks, adequate support arrangements shall be provided to transfer thrusts to the surrounding ground. No additional payment shall be made for such additional support works.

505. THRUST BLOCKS

Pipelines with flexible joints shall be adequately restrained at bends, tees, sluice or butterfly valves, tapers, blank ends, etc. Thrust blocks shall be constructed from Class 20 concrete to the dimensions indicated on Drawings unless otherwise directed by the Engineer. All thrust blocks shall be allowed to cure for at least 7 days and surrounding soil shall be compacted thoroughly before the hydraulic testing of the pipeline.

Support blocks shall be constructed from Class 20 concrete.

Thrust blocks at proposed tie-in points between old and new pipework will be cast at least 7 days prior to the proposed tie-in works and pipeline testing, except that where this is impracticable, in which case a thrust wall shall be constructed (similarly in advance) and the connecting fitting propped initially against this thrust wall by means of a horizontal steel joist with the contact face curved to the outside diameter of the fitting, and fitted with a protective rubber insert. Immediately upon completion, the space between the thrust wall and the propped fitting shall be filled with class 20 concrete, thereby permanently encapsulating the steel joist.

506. PIPE SUPPORTS

Pipe supports shall meet the requirements of BS 3974-1, PNFS 0001 and MSS SP 58.

507. CHAMBERS AND SURFACE BOXES

Gate valves, air valves and fire hydrants etc. shall be provided with suitable chambers or surface boxes in accordance with detailed drawings. In roads and footpaths the boxes shall have metal covers laid flush with the surface. Indicator posts to suit shall also be provided.

508. PIPE LAYING

a) Pipes shall only be laid in the presence of the Engineer or Engineer's Representative unless written authority from the Engineer has been granted

b) Pipes generally shall be laid and jointed in accordance with the manufacturer's instructions. Extra excavation must not be carried out so as to avoid backfill, excessive deviation in joints and other irregularities. Otherwise, the pipe grade will follow the Drawings, with a continuous (but not necessarily uniform) fall towards washout-valves and rise towards air-valves.

c) Prior to laying, damage to linings or coatings shall be repaired in accordance with the manufacturer's instructions. Where, in the opinion of the Engineer, the damage to a pipe coating is significant and notwithstanding the repairs made in accordance with the manufacturer's instructions, the complete pipe shall be further protected by a polythene sleeve. The sleeve shall conform to ISO 8180 for steel pipes and EN 14628 for DI pipes and be of minimum thickness of 200 microns. It shall be strapped beyond the joints of adjoining pipes using a non-metallic strap around the pipe.

   If the damage is excessive and, in the Engineer's opinion, cannot be adequately repaired the Contractor shall replace the pipe(s).

d) For DI pipes, before lowering into the trench or placing in position each pipe or casting shall be slung and sounded with a mallet to test for hair line cracks. Pipes that do not ring true will be discarded. For ferrous pipes with barrier coatings, the coating, and where appropriate the lining of every pipe shall be inspected by use of holiday detectors in accordance with NACE RP 0490. Unless otherwise authorised in writing by the Engineer to carry out such inspections in a nearby storage yard, such inspections shall be carried out at the trench side immediately prior to lowering into the trench.

e) Each pipe shall be thoroughly brushed inside and outside prior to laying and no foreign matter shall be allowed to enter the pipe during or after laying.

f) At the end of each working day the exposed pipe end shall be stoppered up with a stopper plug of appropriate diameter and not merely covered in polythene sheet tied around the end.

g) Every pipe shall be laid separately and shall bear evenly upon the lower bedding or concrete for its full length, holes to receive sockets, couplings or flanges being cut in the bottom of the trench of such size and depth as to allow the joints to be properly made. The pipes shall be laid to true inverts, straight lines and falls, each pipe being separately boned between sight rails.

h) All flanged joints shall be made with jointing rings, which shall be carefully inserted concentric to the bore of the pipe, so that undue stresses shall not be caused in any of the bolts or on the flanges when bolting up. The joint ring shall be compressed gradually and evenly by taking a few turns on each diagonal bolt in succession. Over-tightening shall be avoided. Where one or both of the flanges is itself of plastic, torque-wrenches shall always be used, and the bolts shall first be hand tightened and then diagonally tightened progressively to achieve 5%, 20%, 50%, 75% and finally 100% torque. For metal to metal flanges and if the Engineer is dissatisfied with the degree of care being taken, the Contractor shall provide and use torque-wrenches for this purpose at no extra cost.

i) Mechanical joints shall be made in accordance with the manufacturer's instructions. After successful testing of pipelines, the joints will receive external protection to the Engineer's approval.

j) The threads of any screw connections shall be coated with red lead before the joint is made.

k) Concrete anchor blocks shall be provided at bends, tees, stopped ends, etc. as shown on the drawings or as directed by the Engineer.

l) Where a pipeline crosses roads or railway lines, the pipe shall be sleeved or surrounded with concrete as instructed by the Engineer, and Contractors shall

have been deemed to have made allowance in their rates at the time of Bidding for compliance with the requirements of the relevant authority.

m) For the insertion of valves and other fittings into existing pipelines, pipes may need to be cut. Approved tools and machines specially made for the purpose, shall be provided and used by the Contractor.

n) The Contractor shall, subject to approval of the Engineer, cut pipes to such lengths as directed. Pipes should be cut off clean and square with the axis. Cuts should be made with an approved cutting device dependant on the type of pipe specified. Ends of pipes should be tapered by means approved by the Engineer if mechanical joints are to be used.

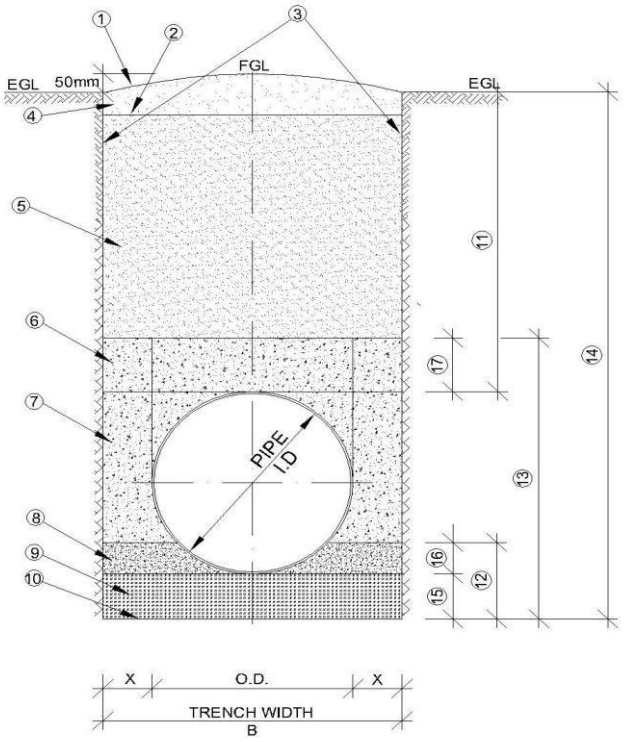
o) The Contractor shall provide and fix wooden drumheads to the open ends of the mains, and similar drumheads shall be used to close the ends of any pipes to exclude dirt and stones, etc. when the pipe laying is not actually in progress. Wooden markers properly inscribed, shall be left projecting out of the ground to indicate the ends of all pipes, where these are buried in the ground in open country. In public highways, a danger sign or other suitable means as approved by the Engineer shall be adopted.

509. BACKFILLING OF PIPE TRENCHES

a) Before commencing the placing of embedment in the trenches, the Contractor shall obtain approval from the Engineer as to the methods he proposes to use and he shall demonstrate by means of tests that the specified compaction can be achieved (according to BS 1377 or ISO 22476 using the "sand replacement" method). The method of compaction and the testing thereof shall be at all times to the approval of the Engineer and in general at a frequency of once every 30 metres unless this is specifically relaxed based on continuously good in-situ test results.

b) Backfilling shall only take place with the prior approval of the Engineer.

c) Typical trench details are shown below:



1. Surface
2. Bottom of road construction (if any)
3. Trench walls
4. Top soil
5. Main backfill
6. Initial backfill
7. Sidefill
8. Upper bedding
9. Lower bedding
10. Trench bottom
11. Depth of cover
12. Depth of bedding
13. Depth of embedment
14. Trench depth
15. Depth of lower bedding
16. Depth of upper bedding
17. Depth of initial backfill

Notes:

i) Compaction is the deliberate densification of soil during the construction process, whereas consolidation is the subsequent time-dependent densification after construction. Attaining cited minimum compaction requirements of 80% at the Engineer's discretion.

ii) The embedment is the arrangement and type(s) of materials(s) around the buried pipeline which contributes to its structural performance. Attaining cited minimum compaction requirements is mandatory for embedment.

iii) Minimum cover is 1000 mm for all pipes. May be reduced at Engineer’s discretion.

iv) The embedment section comprises all materials below the pipe and surrounding the pipe, extending 300 mm above the crown of the pipe. All material above this point comprises the main backfill

v) The embedment section comprises the bedding (lower and upper), the side-fill, and the initial backfill (which extends from the crown of the pipe to 300 mm above the crown)

d) The embedment material shall be free from tree roots, lumps, stones, organic matter, fragments of rock larger than 20 mm, or similar objects, which through

impact or by concentrating imposed loads might damage the pipes. Black cotton soil shall not be used as embedment material.

e) Where pipes are not to be surrounded in concrete or bedding materials (S1 to S4) described above, the pipe zone material placed around the pipes shall be selected and screened as necessary, free from and to the approval of the Engineer.

f) Classification of embedment materials for flexible (steel, uPVC, HDPE) and semi- rigid (DI) pipes is indicated in Table below.

Embedment Class	**Embedment Material Allowed**	**Notes**
S1 and S2	Class S1: Gravel – single size Class S2: Gravel – graded	Normally processed granular materials where specified as bedding for ferrous pipes
S3 - S4	Class S3: Sand and coarse grained soil with less than 12% fines Class S4: Coarse grained soil with more than 12% fines OR Fine grained soil, liquid limit less than 50%, medium to no plasticity and more than 25% coarse grained material	These can be "as dug" soils but require particularly close control when used with low stiffness pipes. Class S3 shall be used for epoxy lined steel pipes whilst Class S4 is suitable for cement mortar lined ferrous pipes

g) Granular material for beddings shall consist of aggregate to BS 882 and shall conform to the grading shown in Table below.

Nominal Pipe	**Grading (mm)**	
	S1 Lower Bedding	**S2 Lower Bedding**
80-100	10 single sized gravel	10 single-size gravel
150	10 to 14 single-size gravel	14 to 5 graded
200-500	10, 14 or 20 single-size gravel	14 to 5 graded or 20 to 5 graded
>500 >1000	10, 14, 20 single-size crushed rock or gravel	14 to 5 graded or 20 to 5 graded

h) The embedment material shall be in accordance with the above specifications, and not less than:

a) Class S3 material for epoxy lined steel pipes
b) Class S4 material for cement-mortar lined ferrous pipes (Ductile)
c) Class S2 material for thermoplastic pipes

i) Where the 'as-dug' trench material meets the bedding class requirements as specified, or will meet the requirements through careful screening and processing, the Contractor may incorporate such material into the embedment, subject to the Engineer's approval. No additional payment shall be made for screening and processing.

j) If the quantity of appropriate embedment material which can be obtained from the pipe trench excavation (with or without screening) is insufficient, the Contractor shall transport suitable material from other excavations on site, or

from off-site. No additional payment shall be made for such imported material

k) For all bedding classes, compaction shall be not less than 90% Modified Proctor Density (MPD) at optimum moisture content (+5% 1 -2%)

l) The placing and compaction of pipe embedment shall only be undertaken in the presence of the Engineer, unless written authority from the Engineer has been granted.

m) Sidefill shall be placed simultaneously on both sides of the pipe in layers not exceeding 150 mm thickness and compacted using hand rammers to achieve the required density, taking particular care to compact the material under the barrel of the pipe and around joints. Layer thickness is however subject to consistently achieving 90% MPD or better, failing which layers shall be reduced in depth as necessary to achieve the necessary compaction.

n) Testing of compaction of the backfilled trenches shall be executed by an authorized testing institute or an authorized professional Engineer, who shall also provide all test devices as well as the documentation and the evaluation of the tests.

The compaction shall be in accordance with Section 3.6 of BS 1377: 1990, Part 4 using a 4.5 kg rammer. In-situ density tests shall be carried out by the sand replacement method in accordance with BS 1377: 1990, Part 9 at every 30 metres or as directed by the Engineer.

After the last layer of the backfill material is compacted a drop penetration test, with 10kg weight according to DIN 4094, should be executed.

The location of the tests shall be agreed with the Engineer, but compaction tests must be implemented minimum every 100m of trench in urban areas and the Contractor is responsible for all works, materials and costs associated with this.

o) Pipes shall never be laid directly on cohesive, rocky or stony material. Where the natural trench bottom meets the bedding class required, this shall initially be loosened to a depth of 10 cm and then recompacted to at least 90% MPD and then the surface loosened on the day of and prior to laying.

p) In rock excavation, the pipes shall be bedded on concrete or selected granular fill to a minimum thickness of 150 mm and the exclusion of rocks and other hard material to at least 300 mm around the pipe, leaving proper joint holes and subsequently making good with selected materials to the Engineer's approval.

q) The main backfill shall be filled with approved backfill material obtained from the trench excavations, free from clay lumps, boulders and rock fragments larger than 100 mm. The material shall be placed in layers not exceeding 150 mm thickness and compacted using approved mechanical rammers.

r) The lower bedding for the pipes shall have a minimum thickness of 100 mm in normal trenches, and 150 mm where rock/stones are present and at designated road crossings. Bedding material shall be compacted in layers not exceeding 50 mm thickness.

s) In trenches where there is a continuous accumulation of ground water the trench shall, after obtaining the approval of the Engineer, be over-excavated by 150 mm and shall be backfilled using compacted free-draining granular material.

t) Where mechanical-ramming of the backfill is employed, the machines shall be to the approval of the Engineer and soil shall be compacted by hand for a depth of

not less than 50 cm to give sufficient cover to the pipes and obviate risk of damage to them before the mechanical rammer is brought into operation. The rammer shall not cease to be used on any length of trench until thorough compaction has been obtained.

u) The pipe trench shall be backfilled entirely without leaving out areas around and at pipe joints uncovered, for subsequent filling. To facilitate the subsequent location of any suspected leaking joints during pipe testing, should this become necessary, the Contractor shall provide marker pegs at regular intervals and/or use a handheld GPS to be able to relocate joint positions.

v) Where minimum cover cannot be maintained, including roads and trafficked areas, then the pipe must either be laid in a protective ferrous sleeve or be protected by a 150 mm thick reinforced concrete slab above the pipe. A minimum of a 150 mm layer of appropriate grade bedding material must first be placed and compacted as a cushion above the crown of the pipe before the slab is laid, and the slab must extend at least 300 mm out beyond either side of the trench.

510. REINSTATEMENT OF SURFACES

All surfaces of roads, fields, paths, gardens, verges, etc. whether public or private which are affected by the operations of the Contractor shall be temporarily restored by him in the first instance and permanently reinstated in the second instance when the ground has consolidated fully.

Temporary reinstatement and permanent reinstatement of all surfaces, affected by the operations of the Contractor shall be carried out and maintained to the satisfaction of the Engineer and the responsible authority or owner.

Temporary reinstatement shall be carried out immediately the trenches are backfilled. Permanent reinstatement shall not be carried out until the ground has consolidated completely. The Contractor shall inform the Engineer before carrying out this work. In the event of further settlement occurring after completion of the permanent reinstatement the Contractor shall forthwith make good the reinstatement to the approval of the Engineer or responsible authority

The Contractor shall be responsible for the temporary reinstatement and permanent reinstatement of all surfaces whether or not the area requiring restoration is within the limits of his excavations if the necessity for the restoration arises from causes due to the operations of the Contractor. The Contractor's prices shall include for restoring all surfaces so damaged to their original condition, as no extra payment will be made for any such work.

Temporary restoration shall be carried out immediately after the excavations have been refilled by returning the excavated material to the position from which it was removed and adding such suitable materials as may be required and consolidating the various materials as the Work proceeds in order to provide a surface that is adequate for the purpose that the original surface fulfilled. Temporary surfaces shall be maintained in a condition satisfactory to the Engineer and/or responsible Authority until the permanent reinstatement is made. In the case of roads, the surface shall be necessary to consolidate the filling and keep the surface fit for traffic, suitable material being added to all places which have sunk or become rough.

For the purposes of temporary and permanent reinstatement in bitumen and murram or gravel surfaced roads the surface width of trenches shall be increased by 300 mm on each side of the trench for a depth of 300 mm to provide a solid abutment for the surfacing material.

Reinstatement of murram and gravel surfaced roads shall consist of approved "as dug" material placed in one layer 250 mm thick thoroughly compacted by an approved roller and surface blinded with fine material so as to leave a tight closed even surface, all to the satisfaction of the Engineer.

Reinstatement of surfaced roads shall be carried out to the approval of the relevant authority.
The responsible authority shall have the right to carry out permanent reinstatement at the Contractor's expense.

Temporary reinstatement of trenches in bitumen surfaced roads shall comprise a layer of compacted hardcore, of minimum thickness 150 mm, topped with a 75 mm layer of surface material taken from the original surface together with any additional material to form a satisfactory running surface. The surface shall be well rolled and sealed with a coat of approved cold applied bituminous emulsion, applied with an approved sprayer at the rate of approximately 2 litres/m^2. The emulsion shall be blinded immediately with quarry dust or sand approved and then rolled with an 8 tonne roller.

The quality and grade of bitumen shall be suitable for the climatic conditions of the area and shall otherwise conform to BS 434.

Permanent reinstatement shall not be made until the ground has consolidated permanently and until approval to do so is received from the Engineer. It shall be carried out with materials similar to those that were used in the original Work to the entire satisfaction of the Engineer and/or responsible Authority, or to the following general requirement:

i. Upper cover layer of fine bituminous asphalt 5 cm
ii. Lower cover layer of coarse bituminous asphalt 7 cm
iii. Upper layer of the foundation of selected excavated material 10 cm, 0-20 mm, Ev=75MN/m2, compacted to 95% of modified Proctor Density (MPrD)
iv. Lower layer of the foundation of selected excavated material 20 cm, 0-63 mm, Ev=75MN/m2, compacted to 95% of modified Proctor Density (MPrD)

In the event of further settlement occurring after the completion of the permanent reinstatement the Contractor shall forthwith make good the reinstatement to the approval of the Engineer or responsible authority.

Alternatively, with the approval of the Road Authority and the Engineer, permanent reinstatement can be carried out immediately, without temporary reinstatement first done. However, this is strictly dependent on the Contractor demonstrating high quality backfilling and compaction, and any approval will not remove the Contractor's liability for road safety and for making good any subsidence that occurs.

Trenches in open ground shall be reinstated to the condition in which the ground was found before excavation was commenced. The final surface of the trench shall be flush with the surrounding ground.

In verges and other grass surfaces the topsoil shall be removed, stored and replaced after consolidation of the filling and planted or seeded with approved grass. Should subsidence occur, it shall be made good with additional topsoil and be replanted with grass or re-seeded. New grass shall be planted if for any reason the grass fails to grow or is destroyed.

All trees, shrubs and plants shall be carefully transplanted and shall be returned to their original location after the refilling of the excavations. Return of old or mature trees may be waived in cases where the age of the tree makes return impracticable, and approved tree seedlings shall be planted in their place. Topsoil shall be carefully set aside and replaced at the surface of the backfilling.

The trenches, channels, gutters and kerbs shall be reinstated to the condition in which they were before excavation was commenced. The final surface of the trench shall be flush with the surrounding ground.

In the case of footpaths the trench shall be refilled and rammed as specified to within 125mm of the surface. A foundation layer of 100mm compacted thickness of approved crushed limestone shall then be laid and compacted. The surface shall be cleaned and primed and the footpath surfacing shall be temporarily reinstated with 25mm compacted thickness of 14 mm nominal size dense wearing course macadam laid and compacted so as to achieve a dense, smooth and even course surface using a roller of 750 to 3000kg mass. Any kerbs shall be reinstated to their original condition.

If at any time any reinstated trench becomes dangerous, the Engineer shall be at liberty to call upon the Contractor to restore it to a proper condition at three hours' notice and should the Contractor fail to carry out the work, have it done at the Contractor's expense.

If the work or reinstatement as carried out by the Contractor is not to the satisfaction of the Engineer and/or the responsible authority and should the Contractor not remedy the defect within one week of being ordered to do so by the Engineer, any remedial work considered necessary may be undertaken by the Employer and/or the responsible authority at the Contractor's expense.

The trench surface shall be thus maintained until the end of the Period of Maintenance or permanent reinstatement is ordered by the Engineer. Where permanent reinstatement is ordered by the Engineer the temporary surface and part of the foundation shall be removed to 50mm depth to permit the construction of a tiled or paved surface to match the original surface. An approved tiled or paved surface shall then be laid and bedded on sand or mortar to an even finish.

511. MAKING GOOD SUBSIDENCE AFTER REFILLING

Should any but very localised subsidence occur of the pipe trench after refilling and before the expiry of the maintenance period, the Contractor shall first demonstrate that such subsidence is only to the backfilling above the pipe and not to the full depth of pipe, embedment, bedding or sub-soil itself.

Should this not be so demonstrated then the Contractor at his own expense shall, excavate and remove the pipe or pipes affected and return the bottom of the trench to grade through a process of over-excavation, re-compaction or use of a lean concrete mix as determined by the Engineer, who shall also determine whether or not the affected pipes may be re-used or replaced.

The affected section or sections will in any event be liable for a further twelve months maintenance period. All refilling necessary due to subsidence in pipe trench backfill shall be thoroughly compacted by ramming.

Any subsidence due to consolidation shall be made up by the Contractor at his own expense with extra compacted material. Should subsidence occur after any topsoil has been replaced, the topsoil shall first be removed before any hollows are made up before being replaced.

512. CLEANING AND STERILISING OF PIPELINES

a) When a pipeline is complete and where applicable, has successfully passed the test, it shall be thoroughly washed out, using if possible, an open end. Thereafter it shall be sterilized by being filled with a suitable solution containing not less than 20 p.p.m. of free available chlorine or such other sterilizing agent as the Engineer shall approve. After standing for 24 hours the main shall again be washed out and refilled with mains water prior to the taking of bacteriological samples. The Contractor shall provide all necessary stop-ends, fittings and chemicals for this work.

b) Emptying and washing out of the pipes shall be done in such a manner as not to damage the trench or cause undue flooding of the vicinity, and the Contractor shall supply and use piping, specials and/or hose as may be necessary to facilitate the flow of water to the nearest drain or watercourse. Water used for washing out and sterilizing may be supplied by the Employer when a suitable supply is available but all expenses should be payable by the Contractor.

Before any section of the main is put into use, a bacteriological sample or samples will be taken by the Engineer's Representative and only on receipt of a satisfactory certificate from a Medical Research Laboratory or similar organisation will the main or section of main be permitted to be put into supply and be considered as having been substantially completed.

Any expenditure involved in providing facilities or materials for the taking of samples shall be included in the Contractor's Bidding rates and the Engineer will specify and shall be the sole judge as to the number of samples required and the points at which they are to be taken.

The cost of the bacteriological examination will be borne by the Employer but if the sample or samples are not satisfactory, the cost of any subsequent analysis will be borne by the Contractor.

513. CONNECTIONS TO AND DIVERSIONS TO EXISTING PIPEWORK

General

The Contractor shall be responsible for connecting new pipework and service connections laid under the Contract to existing pipework, and for blanking-off existing pipework and service connections. The connection shall be made in a manner to minimize any disruption to supply.

Before blanking-off or making a connection to existing pipework the Contractor shall notify the Engineer in writing no less than 14 days in advance of the date on which he proposes to carry out the work. After giving such notice the Contractor shall obtain from the responsible Authority agreement on the precise date, times and method that the connection will be made. The connection or blanking-off shall be made at such times of the day or night as stipulated by the Engineer.

The Contractor shall prepare a detailed method statement, programme of the work and a schedule of all plant and materials to be used and shall obtain the approval of the Engineer not less than 72

hours before commencement of the work. The programme shall allow for the immediate re-commissioning on completion of the work.

The Contactor shall be responsible for locating the exact line and level of the existing pipework and service connections and shall agree with the Engineer and the responsible Authority the precise location of the connection or blanking-off.

Materials

Before commencing the connection the Contractor shall excavate trial pits as necessary and shall check the outside diameter of the existing pipework and ensure that the couplings to be used for making connections to the existing pipework and the materials used for blanking-off existing pipework are dimensionally suitable.

The Contractor shall ensure that all the materials are on site not less than 24 hours before the commencement of the work.

Preliminary Work

The Contractor shall execute all works possible before disconnection of the supply including:-

i. Excavation and supports to the excavation.
ii. Blinding with concrete the immediate working areas, but not less than the whole of the bottom of the excavation.
iii. Putting in all drains, or where this is not possible a sump of adequate size from which a pump may operate.
iv. Casting the floor of any chamber which is later to be constructed around any of the works.
v. Casting the thrust blocks or any other works which may be required.
vi. Exposing and cleaning pipes in readiness for the work.

Carrying out the Work

The Contractor shall be responsible for emptying the section of existing pipework on which the work is to be carried out, by a method agreed with the Authority and approved by the Engineer.

The Contractor shall take all precautions necessary to prevent dirt and other foreign matter entering the pipelines.

The Contractor shall provide at the Site a sufficient quantity of clean water containing approximately 10 parts per million (10mg/l) of chlorine before proceeding with the cutting of the existing pipeline. Each item of pipework including the joints shall be submerged in the solution for a minimum period of 15 minutes immediately prior to installation.

Water Pipes and Chambers to be Abandoned

Where existing water pipes are to be replaced with new pipework the existing pipework is to be abandoned. Where new works conflict with existing pipework to be abandoned, abandonment of pipework shall consist of removal and disposal to a site approved by the Engineer. Water supply pipework shall not be abandoned until suitable alternative means of supply are in place and ready for connection.

Where chambers are to be abandoned these shall be broken down and disposed of and the void filled and compacted with suitable material approved by the Engineer. Chambers deeper than 1 metre will be broken down to 1 metre below finished ground level and the remaining void filled and compacted with suitable material approved by the Engineer.

514. CLEARANCE OF SITE

The Contractor shall remove all surplus pipes, specials and other fittings from the site as directed by the Engineer. The site of works shall be levelled and all surplus excavation, debris, cut trees or bushes shall be carted to approved tip sites.

All existing pipes remain the property of the Employer and any existing pipes removed during the works must be handed over or disposed of as instructed by the Engineer, including transport and unloading for a maximum of 10km, for which the Contractor will cover the expense.

515. TESTING OF WATER RETAINING STRUCTURES

As soon as possible after completion of water retaining structures viz. storage reservoirs etc. they shall be tested for water retention by filling to the normal maximum level with water at a uniform rate of not greater than 2m in 24 hours.

When first filled, the water level should be maintained by adding of further water for a stabilizing period while absorption and antogenous healing take place. This period may be 7 days after which the level of the water surface should be recorded at 24 hour intervals for a test period of 7 days. The structure shall be considered satisfactory if, during this period the total permissible drop in level, after making due allowance for rainfall and evaporation, should not exceed 1/500th of the average water depth of the full tank, 10mm or another specified amount all in accordance with SRN 102. Water used in testing the structures shall be supplied by the Contractor. Sterilization of the structures is to be done as specified by the Engineer and sampling of water carried out similar to Clause 512.

Water used in testing of water retaining structures shall be supplied by the Contractor. The Contractor shall carry out all work which may be necessary for making temporary connections to the existing mains to obtain water for testing at his own expense.

This test shall be carried out before any backfilling has taken place.

In the event of any water retaining structures failing to pass the test, the Contractor shall make good and re-test at his own expense.

516. STERILISATION OF WATER RETAINING STRUCTURES

A strong chlorine solution (about 200 milligrams per litre) shall be sprayed on all interior surfaces of the hydraulic structure. Following this, the structure shall be partially filled with water to a depth of approximately 30 centimetres. During the filling operation, a chlorine water mixture shall be injected by means of a solution feed chlorinating device. The dosage applied to the water shall be sufficient to give a chlorine residual of at least 50 milligrams per litre upon completion of the partial filling operation. Precaution shall be taken to prevent the strong chlorine solution from flowing back into the lines supplying the water. After the partial filling has been completed, sufficient water shall be drained from the lower ends of the appurtenant piping to insure filling the lines with the heavy chlorinated water.

Chlorinated water shall be retained in the hydraulic structure and in the associated piping long enough to destroy all non-spore-forming bacteria and, in any event, for at least 24 hours. After the chlorine-treated water has been retained for the required time, the chlorine residual shall be at least 25 milligrams per litre. All valves shall be operated while the lines are filled with the heavily chlorinated water.

Water used in sterilising the water retaining structures shall be supplied by the Contractor. The Contractor shall carry out all work which may be necessary for making temporary connections to the existing mains to obtain water for testing at his own expense.

6. DRAINS, SEWERS AND MANHOLES

601. EXCAVATION FOR DRAINS, SEWERS AND MANHOLES

The ground shall be excavated to the lines and depths shown on the drawings or to such other lines and depths as the Engineer may direct. Excavations taken out to a greater depth than is necessary shall be filled to the required level with approved material as specified for the pipe bed at the Contractor's own cost. Trenches shall be of sufficient width to enable the pipes to be properly laid and jointed. In case of pipes of greater diameter than 300mm, the width of trench shall be external diameter of pipe, plus 400mm. When any excavation has been taken out and trimmed to the levels and dimensions shown on the drawings or as directed by the Engineer, the Engineer shall be informed accordingly so that he may inspect the completed trench and no excavation shall be filled in or covered with concrete until it has been so inspected and the Contractor has been authorized to proceed with the work. All surplus materials from such excavations not required for refilling shall be carted away to tips, or otherwise disposed of, as directed. All excavations shall be kept dry, and all bailing and pumping, timbering, shoring and supporting of sides that may be required, and any refilling, ramming and disposal of surplus materials necessary in carrying out the excavations and backfilling of trenches shall be taken to provide a solid and even bed for barrels of the pipes and, where a concrete bed is not specified, the floor of the trench shall be properly shaped to receive the sockets and the backfill must be thoroughly rammed along the sides of the pipe.

The rate of excavation in the Bill of Quantities shall include for keeping trenches dry and for all bailing, pumping, timbering, shoring and supporting of sides that may be required.

602. SUPPORTS FOR PITS, TRENCHES AND OTHER EXCAVATIONS

The sides of pits, trenches and other excavations shall, where necessary, be adequately supported to the satisfaction of the Engineer, and all such excavations shall be of sizes sufficient to enable the pipes and bedding to be laid accurately, and proper refilling and compacting to be carried out.

The Contractor shall take all precautions necessary for the safety of adjoining structures and building by shoring, opening in short lengths or otherwise, during the time the trenches are open.

603. ROCK CUTTING IN TRENCHES FOR PIPES

Where solid rock is met within trenches, it shall be cut out to a depth of 100mm below the intended level of the bottom of the pipes, and replaced with 100mm of approved material as specified. In measuring such rock excavation the Contractor will be allowed a width of 400mm more than the external diameter of the pipes to a level of 100mm below the bottom of the pipes. The price inserted in the Bill of Quantities shall be held to cover all expenses in connection with excavating the rock, backfilling after laying of pipes and disposing of surplus material as directed by the Engineer.

604. WATER IN TRENCHES FOR PIPELINES

Trenches shall be kept free from water at all times during construction of works until, in the opinion of the Engineer, any concrete or other works therein are sufficiently set, and the Contractor shall construct any sumps or temporary drains that the Engineer may deem necessary. The Contractor shall be responsible for the removal and disposal of all water entering the excavations from whatever source and shall deal with and dispose of such water in a manner

approved by the Engineer so as to ensure that excavations are kept dry while ensuring that the disposal of this water does not cause a nuisance to adjacent plot holders or works.

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

605. LAYING AND JOINTING RIGID JOINTED CONCRETE PIPES

Concrete pipes shall be laid true to line and level, each pipe being separately boned between sight rails.

For spigot and socket joints, the spigot of each pipe shall be placed home in the socket of the one previously laid, and the pipe then adjusted and fixed in its correct position with the spigot of the pipe accurately centred in the socket. A ring of tarred rope yarn shall next be inserted in the socket of each pipe previously laid and driven home with a wooden caulking tool and wooden mallet, such yarn when in position shall be 25mm in depth. The socket shall then be completely filled with cement mortar 1 to 2 as specified in Clause 1010 and a fillet of the same worked all round the side. The fillet shall be levelled off and extend for a length of not less than 50mm from the face of the socket.

For 'Ogee' jointed pipes, the joints shall be thoroughly cleaned before laying, and cement mortar shall be applied evenly to the ends for jointing so as to completely fill the joint. The pipes shall then be neatly pointed with a band of cement mortar approximately 125mm wide and 20mm thick. The inside of each joint shall also be pointed up as the work proceeds.

Special care shall be taken to see that any excess of cement mortar etc. is neatly cleaned off while each joint is being made and any earth, cement or other material cleaned out of the pipes by drawing a tight-fitting wad through them as the work proceeds, or by other approved means. A properly fitting plug shall be well secured at the end of the last laid pipe and shall be removed only when pipe laying is proceeding. The trenches, pipes and joint holes shall be kept free from water until the joints are thoroughly set.

Where shown on the drawings or directed by the Engineer, concrete pipes shall be bedded and haunched or surrounded with concrete as specified in Clause 619.

The price inserted in the Bill of Quantities shall include for providing, laying and jointing of pipes.

606. PIPES LAID WITH OPEN JOINTS

Concrete porous pipes shall be laid unjointed with a space of 12mm between the spigot and the inner end of the socket.

All pipes shall be packed and surrounded as directed by the Engineer with approved broken stone, sand or gravel aggregate, to the gradings as shown on the drawings or stated in the Bill of Quantities. The prices inserted in the Bill of Quantities shall include the trench excavation, providing and laying pipes, supplying and placing graded packing material, refilling trench and disposing of surplus all as specified.

607. CAST IRON PIPES

Cast iron pipes and special castings shall be supplied, laid and jointed with lead wool properly caulked to form perfectly uniform and watertight joints, and when laid and jointed they shall be

true to line and level.

Where cast iron pipe drains are laid on unstable ground or ground which is likely to settle appreciably over a period of years they shall be pointed by means of an approved self adjusting or screwed gland joint as directed by the Engineer.

608. DRAINS TO BE LEFT CLEAN ON COMPLETION

On completion, all drains, manholes, etc. shall be flushed from end to end with water from an approved source and left clean and free from obstructions.

609. REFILLING TRENCHES

Trenches shall be refilled with suitable excavated material of 100mm surround but not before the work has been measured and approved by the Engineer. For pipes which are not surrounded with concrete, the first layer of filling material shall be free from stones and shall not be thrown directly on to the pipes, but shall be placed and packed with care all round them. All filling shall be deposited and compacted in layers, not exceeding 225mm loose depth, to a dry density not less than that of the adjoining soil. The last 450mm of filling must be returned in the order in which it has been removed. Timber and framing shall be withdrawn ahead of the layer to be compacted, care being taken to keep the sides of the trenches solid and to fill all the spaces left by the withdrawn timber.

610. CONNECTIONS OF EXISTING SEWERS AND DRAINS

Where shown on the drawings, existing sewers and drains shall be properly extended, connected and jointed to new sewers, culverts, drains or channels. All such connections shall be made during the construction of the main sewer, drain or other work and a record of their positions kept for future use or reference. Where pipe connections are made to a sewer, stone pitched or lined channel, the pipes shall be well and tightly built into the concrete, or masonry work and be so placed as to discharge in the direction of the main sewer, drain or channel and with the end of the pipe carefully cut to the necessary angle. Where the connections are between pipe sewers or drains, special connecting pipes as shown on the drawings shall be supplied and be truly laid and properly jointed.

611. MANHOLES AND INSPECTION CHAMBERS

Manholes and inspection chambers shall be constructed in accordance with the drawings and in the position shown on the drawings or directed by the Engineer. Foundation slabs shall consist of concrete of the appropriate classes as specified on drawings. The side walls shall consist of similar concrete or building stone as specified in Clause 1007 in accordance with the drawings.

The side walls shall be fair faced or rendered internally as specified on drawings. They shall be brought up vertically to receive a precast slab formed of concrete of the appropriate classes specified and reinforced all as shown on the drawings. Cast iron manhole covers and frames as specified in Clause 1032 shall be provided and frames shall be bedded in cement mortar 1 to 3 and so set that the tops of the covers shall be flush at all points with surrounding surface of the footway, verge or carriageway, as the case may be. Any slight adjustment of the slab level which may be necessary to accomplish this shall be effected by topping the side walls with concrete integral with the slab.

If required, half channel pipes, bends and junctions as specified in Clause 1040 shall be laid and bedded in cement mortar 1 to 3 to the required lines and levels, and both sides of the channel

pipes shall be benched up with concrete of the appropriate class and finished smooth to the slopes and levels as shown on the drawings or directed by the Engineer. The ends of all pipes shall be neatly built in and finished flush with cement mortar 1 to 3. Where the depth of the invert exceeds 1 metre below the finished surface of the carriageway or the adjacent ground, step irons as specified in Clause 1033 shall be built in with alternate steps in line vertically and with such additional hand irons as the Engineer may direct.

All manholes when completed shall be watertight and to the satisfaction of the Engineer. The prices inserted in the Bill of Quantities shall include for excavation, provision of all materials, construction, refilling and disposal of surplus.

612. PRECAST CONCRETE MANHOLES

Precast concrete manholes as specified in Clause 1040 shall be supplied and laid generally in accordance with Clause 611 and the drawings.

613. GULLY CONNECTIONS

Connections from gullies to sewers and surface water drains or ditches shall consist of concrete pipes and fittings as specified in Clause 509 jointed with cement mortar 1 to 3 as specified in Clause 1010. All pipes, bends and junctions shall be laid to the lines and levels shown on the drawings or as directed by the Engineer.

614. SURFACE BOXES, COVERS ETC.

Surface boxes, manholes and other covers lying within the site of the works, shall be raised, lowered, altered or removed as directed by the Engineer.

615. GULLIES

Gullies complete with gratings and with rodding eyes where necessary all as specified in Clause 1024 shall be supplied and laid in accordance with the drawings. Where directed by the Engineer, precast concrete gullies shall be laid on and surrounded with 100mm of concrete of the appropriate grade. The concrete surround is to be brought up to the underside of the frame or flush with the top surface as the case may be. Masonry gullies shall be constructed from 225mm building stone and rendered internally. The rates included in the Bill of Quantities shall include for excavation, provision of all materials, construction, making junctions with connections to main drains, accurate setting of frames to line and level, refilling and disposal of surplus materials. Gullies shall be trapped where leading into foul sewers or into combined foul and surface water sewers.

616. COMPLETION OF DRAINAGE WORKS

All sub-soil and surface water drains shall be completed in advance of the construction.

617. TEMPORARY STOPPERS

Junction pipes which are laid but not immediately connected to gullies shall be fitted with temporary stoppers or seals, and the position of all such junctions shall be clearly defined by means of stakes or training wires properly marked and labelled.

618. PROVISION FOR FUTURE CONNECTION TO MANHOLES

Inlet pipes of the required diameters shall be built into the walls of manholes and elsewhere for future use and shall be of the diameters shown on the drawings. The external ends

of all such connections shall be sealed off with temporary stoppers, approved by the Engineer. The pipes shall be laid and jointed as specified in Clause 611 and during the placing of the concrete they shall be adequately supported.

619. SURROUNDING OR HAUNCHING OF PIPES WITH CONCRETE

Surrounding or haunching of pipes shall be carried out using concrete of the appropriate grade. In carrying out this work the Contractor shall take care to pack the concrete under and around the pipes to ensure even bedding and solidity in the concrete and the concrete shall not be thrown directly on to the pipes. The upper surface of the concrete shall be struck off with a wooden screed or template and neatly finished off. The rates shall include for any formwork that the Contractor requires to use under this item.

620. INVERT BLOCK AND STONE-PITCHED DRAINS

Precast concrete invert blocks and side slabs shall be formed of concrete of the appropriate grade to the dimensions shown on the drawings. Each course of side slabs required in the Bill of Quantities shall be interpreted as one complete row of side slabs to one side of the channel concerned. Stone used for channels shall be 225mm x 100mm building stone. Drains should not normally be laid to a radius of curvature less than 10 times the actual width of the drain.

Invert block and stone-pitched drains shall be constructed in the positions and to the levels and dimensions shown on the drawings and laid to true line and even fall. Where under- filling is required it shall be in 100mm maximum thickness layers of compacted murram. The earth sides to such channels shall be neatly finished to a slope of 1 to 1 or such other slope as the Engineer may direct Invert blocks and side slabs shall be laid on a 100mm minimum thickness of compacted murram and be neatly jointed with cement mortar 1 to 3 as the work proceeds. The excavation, murram bedding, providing, laying and jointing invert blocks or stone, backfilling and disposal of surplus shall all be as specified and all in-situ connections shall be in concrete of the appropriate grade.

621. TESTING OF JOINTED PIPES AND MANHOLES

Sealed jointed drains, up to and including 600mm diameter shall be tested in sections (e.g. between manholes) by filling with water under a head of not less than 1 metre. Drains found to be water-tight after a period of 30 minutes will be passed as satisfactory but the water must be retained in the pipes until a depth of at least 450mm of filling has been deposited and compacted on top thereof. Drains failing to stand the test shall be taken out and the pipes re-laid and re-jointed until completely water-tight.

Drains exceeding 600mm in diameter shall be tested by means of a smoke test before they are covered up. Both ends of the lengths of drain to be tested shall be sealed to the satisfaction of the Engineer, and smoke shall then be pumped into the section from an approved machine. Should any joint in the section show an escape of smoke, the section shall be taken out and the pipes re-laid and re-jointed until there is no further escape of smoke.

Should the Engineer so direct, manholes shall be tested by completely filling with water, and there shall be no appreciable loss over a period of 2 hours.

On completion of the works, or at suitable intervals during construction, infiltration tests will be carried out. The permissible amount of infiltration shall be 1 litre per hour per linear metre of nominal internal diameter.

The Contractor shall provide all labour and apparatus for the above tests.

All testing will be done in accordance with the procedure of the British Standard Code.

622. PIPES WITH RUBBER RING JOINTS

Rubber rings complying with SRN 308 will be provided by the Contractor. They will be laid in the socket and the pipes then jointed as specified. The jointing of pipes shall be carried out in accordance with manufacturer's instructions and in conformity with any modifications proposed by the Engineer.

623. LAYING, JOINTING AND BACKFILLING FOR FLEXIBLE JOINTED PIPES

The Contractor shall ensure that any hard spots and loose stones are removed from the formation prior to laying of bedding materials. The Contractor shall lay a bed of thickness 100mm consisting of granular material i.e. sand, gravel, or approved soil of friable nature.

After laying of pipes the Contractor shall lay bedding material on the sides of the pipe compacted by tamping into soffit of sewer.

After completion of this operation the Contractor shall lay the bedding material on top of the pipe in 150mm layers to a thickness of 300mm. The material is to be compacted by tamping. However, precautions are to be taken to avoid excessive tamping on top of the pipe. The remaining trench excavation is to be backfilled to comply with Clause 609 of specification.
The pipes shall be laid with flexible ring seal joints provided that solvent cement joints could be used for fittings where necessary subject to the approval of the Engineer. Pipes and fittings shall be checked for deformities prior to laying. Deformed pipes and fittings shall not be accepted.

Flexible Rubber Ring Joints

The Contractor shall ensure that the spigot end is free from grit, dust or dirt and sealing rings should be seated evenly in the socket grove. Pipe lengths and fittings are supplied with a chamfer on the spigot. Where pipes are to be cut or are supplied without a chamfer on the spigot end the Contractor shall ensure that the pipe is cut square and then form a chamfer on the spigot end with a medium file to an angle of 15 degrees. Remove saw flashing by scraping with a pen-knife.

Expansion Gap

It is necessary to leave a gap between the edge of the spigot end and the base of the socket to allow for expansion. Moulded fittings are supplied with an embossed line indicating the correct depth of insertion. In other cases where the marking is not done, the Contractor shall ensure that an expansion gap of at least 3mm per metre length of pipe or at least 15mm per pipe length is provided. This can be done by marking spigot ends or by pushing spigot fully home, making a small mark on pipe and then withdrawing the pipe by 15mm.

After completing jointing the pipe shall be laid on the prepared bed making sure that a suitable depression is created in the bed for the socket.

Solvent Cement Joints

For solvent cement joints make sure that mating surfaces are clean and free of grease and dirt. Roughen mating surface with sandpaper, clean both surfaces with cleansing fluid using a clean cloth. Apply solvent cement on both mating surfaces. Without delay bring mating surfaces together and hold in position firmly for a few seconds. A layer of cement should be visible at the edges. Joints should not be disturbed for at least 10 minutes after assembly.

7. CONCRETE

701. SCOPE OF SECTION

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.

702. 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 mold, bay or formwork, etc. and also to the volume which has to be filled. Pours in vertical succession are referred to as lifts.

703. THE DESIGN OF CONCRETE MIXES

a) Cement

Cement for structural concrete shall be CEM I – 42.5 to KS EAS 18-1 and KS EAS 183

b) 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 7.1, in which the class designation includes two figures. The first figure is the nominal strength at 28 days expressed in N/mm^2 and the second figure is the maximum nominal size of aggregate in the mix expressed in millimetres.

c) 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:-

Table 7.1 - Concrete Classes and Strengths

Class of Concrete	Nominal Strength N/mm²	Maximum Nominal Size of Aggregate mm	Maximum Water / Cement Ratio		Trial Mixes Target Mean Strength (Clause 401 c) N/mm²	Early Works Test Cubes (Clause 401 d)	
			A	B		Any one Cube N/mm²	Average of any Group of 4 Cubes N/mm²
10/75	10	75	0.60	0.55	13.5	8.5	13.3
15/75	15	75	0.60	0.50	21.5	12.8	20.0
15/40	15	40	0.60	0.50	21.5	12.8	20.0
15/20	15	20	0.57	0.50	21.5	12.8	20.0
20/40	20	40	0.55	0.48	31.5	17.0	27.5
20/20	20	20	0.53	0.48	31.5	17.0	27.5
20/10	20	10	0.50	0.48	31.5	17.0	27.5
25/40	25	40	0.52	0.46	36.5	21.3	32.5
25/20	25	20	0.50	0.46	36.5	21.3	32.5
25/10	25	10	0.48	0.46	36.5	21.3	32.5
30/40	30	40	0.50	0.45	41.5	25.5	37.5
30/20	30	20	0.48	0.45	41.5	25.5	37.5
30/10	30	10	0.47	0.45	41.5	25.5	37.5
40/20	40	20	0.46	0.43	51.5	34.0	47.5
40/10	40	10	0.45	0.43	51.5	34.0	47.5

NOTES: 1. Under water/cement ratio, column A applies to moderate and intermediate exposure, and column B applies to severe exposure. See NOTE after Table 7.2.

2. In case of concrete having a maximum aggregate size of 40mm or less, 150mm cubes should be used.

   In case of concrete having a 75mm or larger aggregate, 200mm cubes should be used.

   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 7.1 but in any case not less than the minimum necessary

for impermeability and durability shown in Table 7.2.

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 that that shown in Table 7.1 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 percent.

Table 7.2 - Minimum Cement Content

Minimum Cement Content - kg/m^3 of Compacted Concrete			
Class of 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 drying — Surface exposed to driving rain; alternate wetting exposure and drying; exposure 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.

d) 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:-

a. The slump of the concrete shall be determined.

b. Six test cubes shall be cast from each batch. In the case of concrete having a maximum aggregate size of 40mm or less, 150mm cubes shall be used. In the case of concrete containing 75mm or larger aggregate, 200mm cubes shall be used and in addition any pieces of aggregate retained on a 53mm BS sieve shall be removed from the mixed concrete before casting the cubes.

c. Three cubes from each batch shall be tested for compressive strength at seven days and the remaining three at 28 days.

d. 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 7.1.

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.

e) 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 additional

requirements as set out below.

Six number 150mm or 200mm cubes as appropriate shall be made from each sample and shall be cured and tested all in accordance with BS 1881, 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 $20m^3$ 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

1) 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 25mm 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

2) 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.

3) 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.

4) Until such time as sufficient test results are available to apply the method of control described in 5) 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 7.1 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 7.1 under the same heading.

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

5) 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 (Table 7.3) 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 not be less than the figure given below:-

Table 7.3 - Minimum Current Margin For Test Cubes

	Minimum Current Margin for		
	10N/mm^2	**15N/mm^2 & above**	**20N/mm^2**
After 20 batches	3.3	5	7.5
After 50 batches	1.7	2.5	3.8

Failure to comply with requirements:

If any one test cube result in a group of four consecutive results is less than 85% 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% of the nominal strength or if the average strength of the group 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 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

701(b) and 701(c) of this Section of the 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 SRN 117.

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.

704. 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 the arrangements he proposes to make.

Concrete for the Works specifically for Treatment Works Units and Storage Reservoirs shall be and mixed using an automatic batching plant in one or more central location. 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 for 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.

The mixing of concrete shall be carried out at central plant located at a site remote from place of discharge of mixed concrete. The mixed concrete shall be transported from the central plant using transit lorry mixers and/or agitator trucks.

Batching and mixing plants shall be modern efficient equipment complying with the requirements of SRN 118 and capable of producing a uniform distribution of the ingredients throughout the mass. Truck mixes shall comply with the requirements of SRN 121 and shall only be used with the prior agreement of the Engineer. If the plant proposed by the Contractor does not fall within the scope of SRN 118, it shall have been tested in accordance with SRN 119 and shall have a mixing performance within the limits specified in SRN 118.

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 drainage water 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 aggregate 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 SRN 118 and checked against accurate weighs and volumes when required by the Engineer.

The weighs of cement and of each size of aggregate as indicated by the mechanisms employed shall be within a tolerance of plus or minus two percent of the respective weights 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.

705. HAND-MIXED CONCRETE

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

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

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

706. 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 25mm. The mixed concrete shall be transported using agitator trucks or transit truck mixers. The agitating speed of the drum shall be between 2 and 4 rpm. The interval between feeding of water into the mixer drum and final discharging of the concrete shall not exceed one hour.

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

707. PLACING OF CONCRETE

a) Consent for Placing

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

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

b) Preparation of Surface to Receive Concrete

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

Existing concrete surfaces shall be prepared as set out in Clause 714. Before deposition of further concrete they shall be clean, hard and sound and shall be wet but without any free-standing water.

Any flow of water into an excavation shall be diverted through proper side drains to a sump, or be removed by other suitable methods which will prevent washing away the freshly deposited concrete or any of its constituents. Any underdrains constructed for this purpose shall be

completely grouted up when they are no longer required by a method agreed by the Engineer.

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

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

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

c) Chutes

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

d) Concrete Pump or Placer

The type and capacity of pump shall be determined to meet the specified requirements, taking into account the placing speed, construction schedule, quality of concrete, location to which concrete is poured, etc. Diameter of the delivery pipes shall be not smaller than 3 times of the maximum size of aggregates to be used in the concrete.

Delivery pipes shall be so installed as to permit easy removal. Before starting the pump or placer operation, about one cubic metre of mortar with the same proportion of water, admixture, cement and fine aggregate as designated for the regular concrete mix shall be passed through the pipe. The pipe shall be set as straight and horizontally as possible to prevent clogging of the concrete mix in the pipe. The supports of the pipe line shall be stiff enough to fix the pipes firmly without adverse effect on forms and reinforcing steel already set in position. Care shall be taken to prevent leakage of the concrete mix from the pipe line or any other part.

Air boosters shall not be used except in conditions where the outlet of the pipe is completely embedded at least 2 metres in fresh concrete.

e) Placing Procedures

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

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

started before completion of the preceeding layer.

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

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

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

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

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

Forms for walls, columns and other thin 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 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 dewatering in the immediate vicinity shall be suspended if there is any danger that such work will disturb the freshly placed concrete.

f) Interruptions to Placing

If concrete placing is interrupted for any reason and the duration of the interruption cannot be forecast or is likely to be prolonged, the Contractor shall immediately take the necessary action to form a construction joint so as to eliminate as far as possible feather edges and sloping top surfaces and shall thoroughly compact the concrete already placed in accordance with Clause 706. All work on the concrete shall be completed while it is still plastic and it shall not thereafter be

disturbed until it is hard enough to resist damage. Plant and materials to comply with this requirement shall be readily available at all times during concrete placing.

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

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

g) Dimensions of Pours

Unless otherwise agreed by the Engineer, pours shall not be more than two metres high and shall as far as possible have a uniform thickness over the plan area of the pour. Concrete shall be placed to the full planned height of all pours except in the circumstances described in sub-clause 705(d).

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

h) Placing Sequence

The Contractor shall arrange that as far as possible the intervals between placing successive lifts of concrete in one section of the Works are of equal duration. This duration shall normally be not less than three or more than seven days under temperate weather conditions unless otherwise agreed by the Engineer.
Where required by the Engineer to limit the opening of construction joints due to shrinkage, concrete shall not be placed against adjacent concrete which is less than 21 days old.

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

708. COMPACTION OF CONCRETE

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

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

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

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

Where the concrete contains aggregate with a nominal size of 75mm or more, vibrators with a

diameter of 100mm or more shall be used.

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

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

709. CURING OF CONCRETE

a) General

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

Curing shall be continued for as long as may be necessary to achieve the above objectives but in any case for at least seven days or until the concrete is covered by later construction whichever is the shorter period.
The above objectives are dealt with in sub-clause 707(b) and (c) but nothing shall prevent both objectives being achieved by a single method where circumstances permit.

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

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

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

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

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

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

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

b) Loss of Moisture

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

If for some reason it is not possible to use impermeable sheeting, the Contractor shall keep the exposed surfaces continuously wet by means of a water spray or by covering with a water absorbent material which is kept wet, unless this method conflicts with sub-clause 707(c).

Water used for curing shall be of the same quality as that used for concrete mixing as stated in Clause 702.

c) Limitation of Temperature Differential

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

i) limiting concrete temperatures at placing as set out in sub-clause 709(b);

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

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

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

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

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

710. 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 701.

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.

711. CONCRETING IN HOT WEATHER

a) General

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

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

b) Concrete Placing in Hot Weather

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

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

i) Shielding aggregates from direct sunshine.

ii) Use of a mist water spray on aggregates

iii) Sun shields on mixing plants and transporting equipment.

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

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

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

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

712. 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.

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 a UF 1 finish.
The concrete shall be levelled and screeded to produce a uniform plain or ridged surface, surplus concrete being struck off by a straight edge immediately after compaction.

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 sufficiently only to produce a uniform surface free from screed marks.

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 7.4 - Surface Tolerances

Class of Finish	Tolerance in mm. See notes		
	A	B	C
UF 1	N/A	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 three metre long straight edge or correctly shaped template placed on the surface and the specified level or position of that surface.

Where dimensional tolerances are given on the drawings or in this Special Specification they shall take precedence over those given in Table 7.4.

713. 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 Clause 721 c) and ordinary Portland cement complying with SRN 103. The mix proportions shall be as stated on the drawings or elsewhere in this Specification or if not stated shall be one part of cement to two parts of fine

aggregate by weight.

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

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

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

714. 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 SRN 103 and aggregates complying with SRN 108-111 including all-in aggregate within the grading limits of SRN 109 and SRN 111.

The weight of cement mixed with 0.3 cubic 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 40mm 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 SRN 115. The aggregate size shall be 40mm to 10mm only. The weight of cement mixed with 0.3 cubic 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.

715. 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 weather conditions during mixing and placing 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 preceeding 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.

716. 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 joint 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 intersection 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 scrabbled by mechanical means or wet sand blasted and then washed with clean water. The indentations produced by scrabbling shall be not less than 10mm deep and shall not extend closer than 40mm 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 711 all as set out in sub-clause 705(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.

717. EXPANSION AND CONTRACTION JOINTS

Expansion and contraction joints are discontinuities in concrete designed to allow 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.

718. WATERSTOPS

All references to waterstops include grout stops.

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

Waterstops shall be made of materials 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 rubber and shall have an elongation at breaking stress of at least 500 percent at 25 degrees centigrade and shall allow a joint movement of at least 50mm.

Polyvinyl chloride (PVC) waterstops shall be extruded from an 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 percent at 25 degrees centigrade and shall allow a joint movement of at least 10mm.

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

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 around 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.

719. GROUTING OF POCKETS AND HOLES AND UNDERPINNING OF BASEPLATES

Pockets and holding-down bolt holes 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 the baseplates 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.

720. REMEDIAL WORK TO DEFECTIVE SURFACES

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

Defective surfaces shall not be made good by plastering.

Areas of honey combing (of a mild nature) which the Engineer agrees may be repaired shall be cut back to sound concrete or to 75mm whichever is the greater distance. In the case of reinforced concrete the area shall be cut back to at least 25mm clear distance behind the reinforcement or to 75mm, whichever is the greater distance. The cavity shall have sides at right angles to the face of the concrete. After cleaning out with water and compressed air, a thin layer of cement grout shall be brushed on to the concrete surface in the cavity and it shall then be filled immediately with concrete of the same class as the main body but with aggregate larger than 20mm nominal

size removed. A form shall be used against the cavity, provided with a lip to enable concrete to be placed. The form shall be filled to a point above the top edge of the cavity.

After seven days the lip of concrete shall be broken off and the surface ground smooth. Surface irregularities which are outside the limits of tolerance set out in Clause 710 shall be ground down in the manner and to the extent instructed by the Engineer.

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

721. BENDING REINFORCEMENT

Unless otherwise shown on the drawings, bending and cutting shall comply with SRN 129.

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. Any discrepancies should be brought to the attention of the Engineer prior to ordering the reinforcement.

Bars shall be bent cold by the application of slow steady pressure. At temperatures below 5 degrees centigrade 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 SRN 129.

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

722. FIXING REINFORCEMENT

Reinforcement shall be securely fixed in position within a dimensional tolerance of 20mm in any direction parallel to a concrete face and within a tolerance of 5mm 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 the bar whichever is the greater.

Unless otherwise agreed by the Engineer, all intersecting bars shall either be tied together with 1.6mm 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 1.6mm 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

currently being placed.

No splices (laps) 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 SRN 937 for gas welding or SRN 919 for metal arc welding. Full strength butt welds shall only be used for steel complying with SRN 126, and if used on high yield deformed bars complying with SRN 126 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 links or damaging the concrete around them. In no circumstances will heating and bending of high yield bars be permitted.

Bars complying with SRN 127 or other high tensile bars shall not be bent after placing in the Works.

Before concrete is placed in any section of the Works which 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.

The Engineer's approval for concrete placing is to be sought in writing for each pour, leaving adequate time to inspect and rectify any defects noted in the formwork, falsework, reinforcement, scaffolding, concreting arrangements, etc.

723. MATERIALS FOR CONCRETE

a) General

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

b) Cement

Cement shall comply with the following Kenya Standards:-

- SRN 103 for Ordinary Portland cement.
- SRN 103 for Rapid Hardening Portland cement plus all special conditions to its use stipulated by the manufacturer.
- SRN 104 for Sulphate Resisting or High Alumina cement.

Cement shall be free flowing and free of lumps. It shall be supplied in the manufacturer's sealed

unbroken bags or in bulk. Bagged cement shall be transported in vehicles with effective means of ensuring that it is protected from the weather.

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

Cement in bags shall be stored in a suitable weatherproof structure of which the interior shall be dry and well ventilated at all times. The floor shall be raised above the surrounding ground level and shall be so constructed that no moisture rises through it.

Each delivery of cement in bags shall be stacked together in one place. The bags shall be closely stacked so as to reduce air circulation but shall not be stacked against an outside wall. If pallets are used, they shall be constructed so that bags are not damaged during handling and stacking. No stack of cement bags shall exceed 3 metres in height. Different types of cement in bags shall be clearly distinguished by visible markings and shall be stored in separate stacks.

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

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

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

The Contractor shall provide sufficient storage capacity on site to ensure that his anticipated programme or work is not interrupted due to lack of cement.
Cement which has become hardened or lumpy or fails to comply with the
Specification in any way shall be removed from the site.

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

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 SRN 103 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 tones 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 & Communications or at the Kenya Bureau of Standards or at any other approved laboratory at the rate of one set of tests as shown in SRN 103 for every 200 tonnes, and at monthly intervals thereafter.

Cement which does not comply with the Specification shall not be used in the
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.

c) Fine Aggregate

Fine aggregate shall be clean, hard and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with SRN 108. All the material shall pass through a 5mm standard sieve and the grading shall be in accordance with Zones 1, 2 or 3 of SRN 109. 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 SRN 135.

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 SRN 117, 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 standard 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 SRN 107, subject also to the further restriction given in the note on total chloride content in Clause 721 (d).

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 SRN 601, subject also to the further restriction given in the note on total sulphate content in Clause 721 (d).

Soundness: After five cycles of the test in AASHO T104 or an approved equivalent, the aggregate shall not show a weight loss of more than 10 per cent.

Organic impurities: If the test for presence of organic impurities in aggregates described below 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 SRN 117 that the presence of organic impurities does not adversely affect the properties of the concrete.

Test for presence of organic impurities in aggregates:

This test is designed to indicate the presence of organic impurities in aggregates used for making concrete.

A 350 cc graduated bottle shall be filled to the 120 cc mark with a sample of the aggregate to be tested and a 3% solution of sodium hydroxide in water added until the volume of aggregate and liquid after shaking gives a total volume of 200 cc. The bottle shall be stoppered, shaken thoroughly and allowed to stand for 24 hours. If, after 24 hours, the colour of the solution is not darker than a pale brown, the aggregate under test may be deemed satisfactory.

d) Coarse Aggregate

Coarse aggregate shall be clean, hard and durable crushed rock, crushed gravel or natural gravel complying with the requirements of SRN 110. 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 SRN 117 that the presence of such materials does not adversely affect the properties of the

concrete. The pieces shall be angular, rounded or irregular as defined in SRN 107.

Coarse aggregate shall be supplied in the nominal sizes called for in the Contract and shall be graded in accordance with SRN 111 for each nominal size.

Other properties shall be as set out below:-

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

The content of hollow and flat shells shall be such as will not adversely affect the concrete quality when tested as set out in SRN 117.

The total content of aggregate shall not be more than the following:

- 40mm nominal size and above 2% of dry weight
- 20mm nominal size 5% of dry weight
- 10mm 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 in SRN 107 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 SRN 601 subject also to the further restriction given in the note on total sulphate content hereunder.

Soundness: After 5 cycles of the test in AASHO 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 of Materials, the aggregate shall be non-reactive.

Flakiness Index when tested in accordance with SRN 113 shall be as set out hereunder:

- For 40mm stone and above, not more than 40
- For 20mm stone and below, not more than 35

If the Flakiness Index of the coarse aggregate varies by more than five units from the average value of the aggregate used in the approved trial mix, then a new set of trial mixes shall be carried out if the workability of the mixes has been adversely affected by such variation.

Impact value: Not more than 45 per cent when tested in accordance with SRN 107. Ten per cent fines value: Not less than 50kN when tested in accordance with SRN 107.

Shrinkage: When mixed with other ingredients in the approved proportions for concrete and tested as set out in SRN 117, the shrinkage factor shall not exceed 0.05 per cent.

Organic impurities: If the test for presence of organic impurities in aggregates shows that more than a trace of organic impurities is present, the aggregate shall not be used in the Works unless the Contractor can show by tests on finished concrete as set out in SRN 117 that the presence of

organic impurities does not adversely affect the properties of the concrete.

Water absorption: The aggregate shall not have a water absorption of more than 2.5 per cent when tested as set out in SRN 112.

Aggregate Crushing Value (ACV): Not more than 35 per cent. Los Angeles Abrasion (LAA): Not more than 50 per cent.
Note: Total chloride and sulphate content:-

The total chloride content, expressed as chloride ion, arising from all ingredients in a mix including cement, water and admixtures shall not exceed the following limits, expressed as a percentage of the weight of cement in the mix:-

For prestressed concrete, steam cured concrete or concrete containing sulphate resisting or super sulphated cement: 0.05 per cent.

For any other reinforced concrete: 0.3 per cent in 95 per cent of all test results provided no result is more than 0.5 per cent.
The total sulphate content expressed as SO3 of all the ingredients in a mix including cement, water and admixtures shall not exceed 0.4 per cent by weight of the aggregate or 4.0 per cent of the weight of cement in the mix, whichever is the lesser.

e) Testing Aggregates

i) 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 labelled to show its origin and shall be accompanied by all the information called for in SRN 107.

Tests to determine compliance of the aggregates with the requirements of Clause 721(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.

ii) 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 SRN 107

- Silt and clay contents SRN 107
- Moisture content SRN 107
- Check on organic impurities

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

Moisture content: As frequently as may be required in order to control the water content of the concrete as required by the Specification.

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 chloride contaminating the concrete. For this purpose the Contractor shall use the rapid field test (the 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 SRN 107 (the Volhard test).

f) Delivery and Storage of Aggregates

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

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

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

g) Water for Concrete and Mortar

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

Water shall be clean and free from harmful matter and shall comply with the requirements of SRN 114.

The Contractor shall carry out tests in accordance with SRN 114 to establish compliance with the Specification.

If water for the works is not available from the Employer's supply the Engineer's approval must be obtained regarding the source of supply and manner of its use. Water to be used with cement or lime shall be free from salt, oil, alkali, organic matter, and other deleterious substances.

h) 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 to comply 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 but not be limited to:-

i. The typical dosage, the method of dosing and the detrimental effects of an excess or deficiency in the dosage.
ii. The chemical names of the main active ingredients in the admixture.
iii. Whether or not the admixture contains chlorides, and if so the chloride ion content expressed as a percentage by weight of admixture.
iv. 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.
v. 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 SRN 149 and shall not have any adverse effect on the properties of the concrete.

i) Reinforcement Steel

Reinforcement which shall comply with the following 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.

- SRN 126 for hot rolled plain bar and high yield deformed bar
- SRN 127 for cold worked steel bar
- SRN 128 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 tested 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 relevant 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.

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 transported 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 Standard at the Contractor's expense.

Dowel Bars

Dowel bars and tie bars shall consist of mild steel, or deformed bars of high yield steel all complying with SRN 126 and they shall be free from oil, paint other than bond-breaking compound, dirt, loose rust and scale.

Dowel bars and tie bars shall be of sizes as shown on the drawings and directed by the Engineer, and shall be straight, free from burred edges, or other irregularities and shall have their sliding ends sawn or, if approved, sheared.

Bond breaking compound for dowel bars shall consist of 66 per cent of 200 pen bitumen blended hot with 14 per cent light creosote oil and, when cold, brought to the consistency of paint by the addition of 20 per cent solvent naphtha or other approved compound meeting the following requirements.

i) It shall not retard or in any other way affect the setting of concrete.

ii) The average bond stress on bars coated with the compound with half their length cast into concrete specimens and subject to pull out tests at 7 days shall not exceed 0.14 newtons per square millimetre and the total movement of the dowel bar relative to the concrete shall not be less than 0.25 millimetres at that stress. The concrete specimens shall be 150 millimetres by 150 millimetres in section and 0.45 metre long and made with the same mix proportions as used in the Works

8. FORMWORK

801. 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 formwork and the concrete until the concrete becomes self supporting.

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

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

802. 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 806.

Ground supports shall be properly founded on footings designed to prevent settlement. Joints in formwork for exposed faces shall, unless otherwise specified, be evenly spaced
and horizontal or vertical and shall be continuous or form a regular pattern.

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

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

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

Formwork shall be provided for concrete surfaces at slopes of 30 degrees to the horizontal or steeper. Surfaces at slopes less than 20 degrees may be formed by screeding. Surfaces at slopes between 20 degrees and 30 degrees shall generally be formed unless the Contractor can demonstrate to the satisfaction of the Engineer that such slopes can be screeded with the use of special screed boards to hold the concrete in place during vibration.

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

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

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

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

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

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

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

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

803. PREPARATION OF FORMWORK

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

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

In cases where it is necessary to fix reinforcement before placing formwork, all surface preparation of formwork shall be carried out before it is placed into position. The Contractor shall not allow reinforcement or prestressing tendons to be contaminated with formwork release agent.

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

Before concrete placing commences, all wedges and other adjusting devices shall be secured

against movement during concrete placing and the Contractor shall maintain a watch on the formwork during placing to ensure that no movement occurs.

804. 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 8.1 and apply to ambient temperatures higher than 10 degrees centigrade. At lower temperatures or if cement other than ordinary Portland are involved, the Engineer may instruct that longer periods be used.

Alternatively, formwork may be removed when the concrete has attained the strength set out in Table 8.1, provided that the attained strength is determined by making test cubes and curing them under the same conditions as the concrete to which they refer.

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

Table 8.1 - Minimum Periods for Formwork Removal

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

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

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

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

805. SURFACE FINISHES ON FORMED SURFACES

Classes of Finish

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

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.

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 thicknessed 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 discoloration and other minor defects shall be remedied by methods agreed by the Engineer.

c) Class F3 Finish (Fair)

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 B.S. 1088 or equivalent material in large sheets. The sheets shall be arranged in an approved 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.

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.

806. TOLERANCES

All parts of formed concrete surfaces shall be in the positions shown on the drawings within the tolerances set out in Table 8.2.

In cases where the drawings call for tolerances other than those given in Table 8.2 the tolerances shown on the drawings shall take precedence.

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

Table 8.2 - Tolerances

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

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

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

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

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

9. MASONRY

901. GENERAL

All masonry work shall be constructed from building stone as specified in Clause 1008.

For culvert headwalls and other small works, the stone shall, unless otherwise specified, be rough dressed. For walls, facing and other exposed works the stone shall unless otherwise specified, be medium chisel-dressed.

902. WORKMANSHIP

The Contractor shall provide and use proper setting out rods for all work.

Stones shall be well soaked before use and the tops of walls shall be kept wet as the work proceeds. The stones shall be properly bonded so that no vertical joint in a course is within 115mm of a joint in the previous course. Alternate courses of walling at angles and intersections shall be carried through the full thickness of the adjoining walls. All perpends, reveals and other angles of the walling shall be built strictly true and square.

The stones shall be bedded, jointed and pointed in 1:3 cement: sand mortar in accordance with Clause 1012 with beds and joints 9mm thick flushed up and grouted solid as the work proceeds.

All masonry work shall be cured in accordance with the relevant requirements to acceptable International Standards and/or as directed by the Engineer.

903. CAST STONEWORK

Cast stone shall be as specified in Clause 1010. Facing stones shall be brought up in courses to a height not exceeding 1 metre at a time, the concrete backing being then brought up and well incorporated into and round the backs of the stones and the projecting metal ties to ensure a complete bond. The stones shall be bedded and jointed as shown on the drawings.

All materials, moulds, mixing, casting and surface treatment, setting, jointing and pointing, and all centering, scaffolding and labour required to complete the cast stonework specified or as shown on the drawings, shall be included in the rates for such work.

10.MISCELLANEOUS ITEMS AND MATERIALS

1001. GENERAL – maybe this is repeated from pipe materials?

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

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

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

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

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

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

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

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

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

j) Where necessary the Contractor shall provide rubber gaskets to comply with SRN 208 and all other bolts, nuts, washers, etc. to undertake jointing at fittings etc.

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

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

The Contractor is referred to the drawings as to the general character of the works and he shall allow in his rates for any extra costs he may consider incurred by reason of the work being in detached positions, in small quantities, difficulty of access or for any other cause. He should also make due allowance for specialist installations taking place during the currency of this contract.

This section of the Specification refers to miscellaneous items. Clauses elsewhere in the Specification shall also be followed where relevant.

1002. SUBMISSION OF SAMPLES

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

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

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

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

1003. AGRICULTURAL TILES AND PIPES

Agricultural tiles and pipes shall be best well-burnt earthenware, true and circular in bore and with an external flat bottom and plain ends suitable for laying with open or butt joints.

1004. ARCHITRAVES AND STOPS

Architraves and stops shall be Class 1 Mvuli matching to the frames and linings.

1005. BLOCKWORK

Building blocks shall be dense concrete blocks complying with the requirements of B.S. 2028, 1364, with faces for plastering and having a compressive strength of 14 N/sq.mm. (Table 2, Type A14).

Blocks shall be obtained from an approved manufacturer and shall be equal to sample blocks previously approved by the Engineer's Representative.

Blocks shall be carefully handled and stored on site and protected from the weather at all times.

Surfaces on which blockwork is to be built shall be kept clean. Blocks shall be well wetted before being laid and the tops of walls where blockwork has been left shall be well wetted before re-commencing. Blockwork shall be built plumb, true to line and level, with all perpends vertical and in line. Blocks shall be built in half bond and alternate courses shall be block bonded at all junctions, no cut block shall be less than half a block. Joints in concrete blockwork shall be well filled with gauged mortar and shall not exceed 10mm in width.

1006. BOLTS AND NUTS

Bolts and nuts shall comply with the relevant requirements of the British Standards as set out below:-

Black Hexagon Bolts, Screws and Nuts	B.S. 4190, Grade 4.6
Metal Washers for General Purpose	B.S. 4320
Black Cup and Countersunk Head Bolts and Screws, with Nuts	B.S. 4993

The items shall preferably have coarse metric threads but items with B.S.W. threads may be used. Bolt lengths shall be sufficient to ensure that nuts are full threaded when tightened in their final position.

1007. BONDING TIES

Bonding ties shall be 75mm wide x 250mm long galvanized bitumen-coated expanded metal strip, cast 100mm into concrete surfaces in contact with block work. The bonding tie used shall be approved by the Engineer's Representative.

1008. BUILDING STONE

All building stone shall be capable of withstanding when wet a crushing stress of 3.5 N/sq.mm. The source of stone shall be approved by the Engineer and stone supplied therefrom shall be free from magadi, overburden, mudstone, cracks, sandholes, veins, laminations or other imperfections.

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

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

The stone shall be sound when tested in accordance with SRN 870 except that:-

i) The treatment shall be repeated for 10 cycles only; and

ii) The second criterion of failure shall be amended to allow for a loss of weight of not more than 20% of its original weight.

1009. CALCIUM CHLORIDE

Calcium chloride shall be of good industrial grade, and shall be obtained from an approved source.

1010. CAST STONE

Cast stone shall be manufactured by an approved manufacturer to the shapes and dimensions shown on the drawings, and shall conform to the requirements of SRN 871: Cast Stone. It shall have a dense and even surface of the texture and colour detailed on the drawings or required by the Engineer. Where indicated exposed faces of the stone shall be formed of a specially graded mix. Metal bond ties of approved manufacture shall be cast in with the stone as shown on the drawings. Samples of the completed stone shall be submitted for the Engineer's prior approval.

All stones shall be protected from damage during transport and erection by means of cement slurry coatings or by other approved methods.

1011. CEMENT GROUT

Cement grout shall consist of Portland Cement and water mixed in the proportion of one part by volume of cement and one and a half parts by volume of water. The grout shall be used within one hour of mixing.

1012. CEMENT MORTAR

Cement mortar shall consist of proportions by volume as specified of Portland Cement and natural sand or crushed natural stone or a combination of both as specified in SRN 135 and SRN 136: Building Sands from Natural Sources. The constituent materials shall be accurately gauged and mixed in an approved manner.

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

1013. CEMENT-LIME MORTAR

Cement-lime mortar shall consist of Portland Cement, hydrated lime and natural sand or crushed natural stone or a combination of both, as specified for cement mortar in Clause
1012. The constituent materials shall be accurately gauged and mixed by volume in an approved manner in the proportions specified.

Cement-lime mortar shall be made only in small quantities as and when required. Any mortar which has begun to set or which has been mixed for a period of more than two hours shall be rejected.

1014. CONCRETE BLOCKS

Solid and hollow concrete blocks for walling shall comply with SRN 804 in every respect.

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

1015. CONCRETE DRAIN INVERT BLOCKS

Precast concrete invert blocks shall be manufactured to the detail drawings supplied from concrete Class 20/10 as specified in Table 7.2 using maximum 12mm size aggregates. If required, cube test certificates shall be supplied by the manufacturer.

1016. CONCRETE SLABS FOR OPEN DRAINS

Precast concrete slabs for lining open drains shall be manufactured to the detail drawings supplied from concrete Class 20/10 as specified in Table 7.2 using maximum 12mm size aggregates. If required, cube test certificates shall be supplied by the manufacturer.

1017. DAMP-PROOF COURSE (D.P.C.)

Damp-proof courses shall be 1000 gauge polythene free from tears and holes and be laid with 150mm minimum laps on and including a levelling screed of cement mortar.

If hessian based metal cored bitumen is accepted for damp-proof courses it shall be lead cored, complying with B.S. 743 paragraph 4, type D, weighing not less than 4.4 kg. per square metre.

1018. DOORS AND WINDOWS

1018.1. Doors

Internal doors shall be hardwood framed solid cored flush doors constructed in accordance with B.S. 459 Part 3, faced both sides with 3mm thick Mvuli veneered plywood and lipped all round with matching hardwood lipping. Moisture content at delivery shall be 12% (+ or - 2%).

1018.2. Metal Doors and Windows

Metal frames shall be of 38/1.5 mm LTZ profile, or similar approved, be manufactured from galvanized steel.

Surface panels for doors shall be manufactured from galvanized 1mm thick sheet steel and shall be corrugated as approved by the Engineer. Respective drawings shall be submitted by the contractor.

Doors for Engineer's offices and operator dwellings shall feature surface panel in the lower half and figured glass in the upper half of the door. LTZ frame to be designed accordingly.
Surfaces of the doors shall be seamless and surface sheets shall be continuously welded along vertical edges.

All welds shall be primed with zinc rich primer.

Doors shall be strong, rigid and neat in appearance and free from warpage or buckle. Corner bends shall be true, straight and the minimum radius for the gauge of metal used.

Two samples of each type of door, door frame, window frame and door and window furniture shall be submitted to the Engineer for approval at least four weeks prior to construction.

Shop drawings of doors, door frames and window frames shall be submitted to the Engineer for approval prior to fabrication. Shop drawings shall show size, material, thickness, mortices,

reinforcement and anchor details.

1019. ELECTRICAL INSTALLATION

The electrical installations will be carried out by Licensed Electrician and complying with the following:-

a) Regulations for Electrical Equipment of Buildings issued by the Institution of Electrical Engineers.

b) Electric Power Act.

c) The Kenya Power Company's Bye-Laws.

d) Relevant current British Standards and Codes of Practice.

e) All the relevant clauses in this Specification.

1020. FENCES AND GATES

Fences generally shall be in accordance with the relevant parts of BS 1722 Part 1: 1986. Chain link fencing shall be Type PL.213 Grade A with 1.8 m high plastic covered chain link mesh. The mesh and line wires shall be galvanized prior to being plastic covered. The posts shall be reinforced concrete.

The straining posts, intermediate posts and struts shall be manufactured and erected complete as specified in BS 1722. The fencing shall be true to line and vertical, following profile of the ground, previously graded so as to prevent access beneath the bottom wire. Gates shall be hung on adequate post, and shall be truly vertical.

Ornamental fabricated metalwork fences and gates shall be constructed of mild steel bar, strip or tube in accordance with the Drawings. All welded joints and drillings for bolts shall be made before painting, and all bolts, nuts and washers shall be galvanized or plated in an approved manner. Any metalwork sunk into the ground shall be treated with two coats of bituminous paint.

1021. FILTER MEDIA

The grading of filter media shall be in accordance to the table of gradings shown on drawings.

Filter media must be free from fines which would clog the air spaces, and free from dirt, silt and all foreign matter.

The media shall be delivered in clean vehicles and if stored it shall be placed on a clean and firm surface and if it is liable to be contaminated, protected with sheets. Different sizes of media shall be kept strictly separate.

The uniformity coefficient as indicated in the particular specifications or drawings should be adhered to and Contractor to submit samples and carry out sieve analysis, organic content, friability tests, etc. to the satisfaction of the Engineer. These tests are to be carried out before the media is placed in filters. All costs arising to be borne by the Contractor.

1022. FIXING IRONMONGERY

The rates for supplying and fixing ironmongery shall include for all sinking, cutting, boring, mortising etc., making good, replacing damaged screws, oiling, adjusting and leaving in good working order and for mastering all keys.

1023. FIXING JOINERY

Doors shall be hung on one or one and a half pairs of butt hinges to give a maximum even tolerance of 2mm all round.

Sub-frames shall be fixed to blockwork with three fixing clamps per side and one dowel let 50mm into the floor and 50mm into the foot of each leg. Linings shall be fixed after completion of other finishings by means of screwing and pellating to sub-frames with matching hardwood pellates. Architraves and stops shall be pinned on, heads punched and filled with tinted filler.

1024. FRAMES AND LININGS

Door frames and linings shall be Class 1 Mvuli mortice and tenon jointed at angles. Sub- frames for internal doors shall be Class 1 Mvuli tongued at angles.

1025. FREE DRAINING FILL

Free draining fill for use as backing to walls shall consist of sound hard stone or broken rock or concrete derived from demolition of structures. The particles shall be roughly cubiform and shall be between 75 mm and 25 mm in size. All smaller particles, dust, rubbish and organic matter shall be excluded.

1026. GABIONS

Gabions shall be of the hexagonal wire mesh type, with mesh dimensions of 80 mm x 100 mm. The minimum dimension shall not exceed 83 mm. Wire shall be galvanised prior to weaving the mesh to resist corrosion from water.

All wire used in the fabrication of the gabion and in the wiring operation during construction shall be in accordance with BS 1052/1980 Mild Steel wire appended having a tensile strength of 38-50 kg/mm^2

All wire shall be galvanised to BS 443: 1982 'Zinc coatings on steel wire' with the minimum weight of Zinc coating in accordance with Table below.

	Diameter (mm)	**Minimum Weight of Coating (g/m^2)**
Mesh wire	2.7	260
Binding and connecting wire	2.2	240
Selvedge wire	3.4	275

All wire used in the fabrication of gabions and in the wiring operations during construction shall, after galvanising, have extruded onto it a coating of polyvinyl chloride compound referred to as

PVC. The coating shall be black in colour, not less than 0.4 mm thickness and shall be capable of resisting deleterious effects of exposure.

Gabions shall be of the following standard sizes:

2m x 1m x 0.5m
2m x 1m x 1m
6m x 2m x 0.3m
Gabions shall be provided with diaphragms to divide the boxes in compartments with a maximum dimension in any direction of 1m.

Joints shall be flexible and shall consist of not less than one and a half full turns of wire, at each mesh point of the joint line.

Gabions shall be as manufactured by Maccaferri, or equivalent. Alternative materials shall be subject to the approval of the Engineer.

Rockfill for gabions shall consist of hardcore i.e. sound hard stone or broken rock. The maximum size shall be 220mm, and the minimum size shall be 120mm; however, up to 10% of some smaller blinding material (min. 75mm) to fill the internal voids between the bigger rocks will be allowed.

Gabions shall be placed in their final positions prior to filling with rock, and shall then be tied together and filled with rock. After filling with rock, the tops shall be closed and securely tied with connecting wire. The larger rocks shall be placed on the upper face of the gabion in order to present a reasonably closed surface. All assembly, erection, stretching, filling with rock and final filing shall be in accordance with the instructions as issued by the manufacturer.

1027. GALVANISED WORK

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

1028. GLAZING

All glass is to be of approved manufacture complying with BS 952 and to be of the quality specified, free from bubbles, smoke wanes, air holes and other defects. Glazing shall be clear or figured glass, set in metallic putty and shall be subject to the approval of the Engineer.

Clear glass shall be used for all windows except in toilets or as otherwise directed by the Engineer.

Glazing shall be carried out in accordance with BS 6262 and the window manufacturer's instructions.

All cracked, broken, scratch, chipped or other with defective glass, shall be taken out and replaced all glazier’s work shall be cleaned and polished inside and out and left perfect on completion.

1029. GULLY GRATINGS AND FRAMES

Gully gratings and frames shall be basically in accordance with the requirements of SRN 846, nominal size 500mm x 350mm except that the gully gratings shall be constructed of mild steel

concrete filled in accordance with the standard detail drawings.

Where indicated as being kerb inlet type, the gullies shall conform to the shape and dimensions given on the detail drawings supplied, but in respect of materials and workmanship conform to SRN 846.

1030. HARDCORE

Hardcore shall consist of sound hard stone or broken rock or concrete derived from excavations or demolition of structures and shall be graded from 150 mm to 50 mm in size, except that sufficient but not excessive blinding materials of smaller sizes may be permitted at the discretion of the Engineer.

1031. HARDWOOD

Hardwood for joinery shall be sound, well conditioned and seasoned Mvuli complying with the requirements of B.S. 1186 Part 1, Class 1. A sample of each representative section for use in the work shall be previously submitted by the Contractor for approval by the Engineer's Representative. Moisture content shall be 12% (+ or - 2%).

1032. HYDRATED LIME

Hydrated lime shall comply with SRN 801: Building Limes, and shall be of the semi- hydrated type.

1033. IRONMONGERY

All ironmongery shall be obtained from a source approved by the Engineer's Representative. Samples shall be submitted before ordering and the articles ordered shall match up with the approved samples. Screws of a like metal shall be used for all fittings.

1034. JOINERY

All exposed joiner's work shall have wrought faces. The prices of all joiner's work shall include for slightly rounded arises.

Where the term 'framing' or 'framed' is made use of, it shall be understood to mean all halvings, dovetails, tenons and hardwood pins and the best known means of putting the work together.

All framed work shall be put together loosely and stacked under cover where a free current of air can circulate and is not to be wedged and glued until it is required for fixing.

All joinery, when brought on the works, shall be stacked under cover.

The Engineer or his representative, shall have full right of access to the joinery works and power to condemn any work not approved and any approval expressed or implied is not to relieve the Contractor from his responsibility and liability to make good any shrinkage or other defects that may appear after the work is fixed.

All joinery to be painted shall be knotted and primed.

The Contractor shall provide all materials, labour, framing, fixing, etc., nails, screws and everything necessary for the proper execution and completion of the work.

1035. JOINT PRIMER

Joint priming compound shall be entirely in accordance with the manufacturer's recommendations for the joint sealant to be used.

1036. JOINT SEALING COMPOUND

Poured joint sealing material shall consist of an approved rubber-bitumen compound, complying with the requirements of SRN 879, or a two component, cold applied compound complying with SRN 879 as stated in the Bill of Quantities. Test Certificates, prepared by an approved testing laboratory, shall be supplied by the Contractor to show that the material does in fact comply in respect of cone penetration, flow and bond with the under-mentioned requirements:

Test Cone Penetration 0.15 kg. for 5 secs. at 25^{o} centigrade using standard grease cone	Hot-poured Materials Penetration not to exceed 9mm	Cold-poured Materials Penetration to be not less than 5mm not more than 27.5mm
Flow On a plane inclined at 75^{o} to the horizontal, 5 hours at 60^{o} centigrade	Flow not to exceed 5mm	Flow not to exceed 20mm
Bond 25mm wide joint extended 12mm at rate of 4mm per hour at 18^{o} centigrade. No more than one specimen in three to develop a crack separation or other opening more than 4mm deep	Five cycles of extension and recompression	Three cycles of extension and recompression

Approved hot-poured materials shall also comply with a requirement whereby when heated for a period of 6 hours at a temperature of 80 degrees centigrade above recommended pouring temperature or 30 degrees centigrade below the safe heating temperature whichever is the greater shall still comply with the flow requirements of this clause.

In addition to materials complying with SRN 879, the Engineer may approve the use of alternative materials provided that they meet the requirements of this clause relating to cold-poured joint sealing compounds.

1037. LIME MORTAR

Lime mortar shall consist of proportions by volume as specified of hydrated lime and naturals and/or crushed natural stone or a combination of both as specified for cement mortar in Clause 1012. The constituent materials shall be accurately gauged and mixed in an approved manner.

1038. MANHOLE COVERS AND FRAMES

Manhole covers and frames shall be basically in accordance with the requirements of SRN 846: Cast Manhole Covers, Road Gully Gratings and Frames for Drainage Purposes except that the manhole covers shall be constructed of mild steel, concrete filled, in accordance with the standard detail drawings.

Foul water sewer manholes shall have triangular Grade "A" heavy duty covers and frames. Circular

manhole covers and frames shall be used on surface water sewer manholes.

1039. MANHOLE STEP IRONS

Step irons of general purpose type shall comply in all respects with SRN 845: Malleable Step Irons.

1040. METAL LOUVERS

Metal louvers shall be pressed from steel sheet of minimum thickness 1.22mm (18 gauge). They shall be rust proofed at works by the hot dip galvanizing process and supplied complete with steel frames and coupling transoms and mullions as required. All metal louvres shall be supplied complete with fine copper mesh woven fly proof screening fixed to the interior face.

1041. MURRAM

Murram shall be from an approved source quarried so as to exclude vegetable matter, loam, top soil or clay. The California Bearing Ratio of the murram, as determined for a sample compacted to maximum density (as defined under SRN 601) and allowed to soak in water for four days, shall not be less than 30%. This C.B.R. is a guide to quality only and the compaction in the work will be judged by density.

1042. PAINTS

All priming, undercoating and finishing paints shall be in accordance with SRN 877 or SRN 878 as appropriate.

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

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

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

1043. PLYWOOD

Plywood generally shall comply with B.S. 1455. That from sources not included in B.S. 1455 shall be of corresponding grades of veneers and types of bonding. Plywood for flush doors shall be Grade I Mvuli veneered.

1044. PRECAST CONCRETE GULLIES

Precast concrete gullies shall be unreinforced and shall comply with the requirements of SRN 854: Concrete Cylindrical Pipes and Fittings including Manholes, Inspection Chambers and Street Gullies.

1045. PRECAST CONCRETE MANHOLES AND INSPECTION CHAMBERS

Precast concrete manholes and inspection chambers shall comply with the requirements of SRN 854: Concrete Cylindrical Pipes and Fittings including Manholes, Inspection Chambers and Street Gullies, and they shall carry the relevant Standard Institution registered certification trade mark, or test certificates shall be furnished by the manufacturer.

1046. PRECAST CONCRETE UNITS

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

a) Formwork for Precast Units

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

Moulds shall be set up on firm foundations so that no settlement occurs under the weight of the fresh concrete.

Moulds shall be constructed so that units may be removed from them without sustaining any damage.

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

b) Reinforcement for Precast Units

Reinforcement in precast units shall comply with the requirement of Clauses 721 i) and 719-720. When preformed cages are used the cages shall be made up on jigs to ensure dimensional accuracy and shall be carefully supported within the could in such a way that they cannot move when concrete is placed. Reinforcement complying with SRN 126 may be tack welded where bars cross to provide rigidity in the cage but reinforcement complying with SRN 127 shall not be welded.

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

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

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

c) Casting of Units

Concrete for precast units shall comply with Clauses 701-723 using the class of concrete specified on the drawings.

If lightweight aggregates are specified, they shall comply with SRN 147.

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

d) Curing Precast Units

Requirements for curing shall be generally as set out in Clause 709.

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

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

e) Dimensional Tolerances of Precast Units

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

f) Surface Finish of Precast Units

The formed faces of precast units shall be finished to Class F3 as set out in Clause 805c) unless another class of finish is specified on the drawings.

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

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

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

g) Handling and Storage of Precast Units

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

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

Units shall be provided with adequate lifting holes or loops, placed in the locations shown on the drawings or agreed by the Engineer and they shall be lifted only by such holes or loops. Where it is not possible to provide holes or loops, suitable sling positions shall be indicated in paint on the units. Units shall be marked indelibly with the reference number and date of casting and shall be stacked on suitable packers which will not damage the concrete or stain the surfaces. Not more than two packers shall be placed under each unit and these shall be located either at the positions of the permanent support points or in positions such that the induced stresses in the unit will be a minimum.

h) Testing Precast Units

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

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

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

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

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

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

1047. PRECAST LINTELS

All precast items shall be marked with the date of casting and shall not be built into the works until they have matured for 28 days. Ends of bar reinforcement shall be hooked or bent as required. The cover for reinforcement shall be 25mm from internal faces and 38mm from external exposed faces. The 'top' of lintels shall be numbered for identification.

Lintels shall have timber or pre-formed inserts cast in for fixing metal windows where required and shall have fair face finish on all surfaces exposed to view and hacked surfaces where plastered.

1048. PREFORMED JOINT FILLER

Preformed joint filler shall be of the thickness shown on the drawings or as stated in the Bill of Quantities.
The material comprising joint filler shall be as stated on the drawings or approved by the Engineer.

1049. PRESSED STEEL TANKS AND TOWERS

The pressed steel tanks (or similar approved), towers and associated materials and fittings shall comply with SRN 909 and SRN 863.

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

The pressed steel tank to SRN 909 (B.S. 1564 Type A(2) or similar approved) shall be supplied

complete with:-

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

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

c) Galvanised access ladder 450mm wide.

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

e) Water level indicator.

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

Connections to the tank shall be welded to the outside of the tank plate and drilled and tapped to suit flanges to SRN 207, NP 16 unless otherwise stated.

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

The tank tower shall be supplied complete with:-

a) Anchor bolts.

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

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

The supports to the tank shall consist of steel joints designed to carry imposed load under each transverse joint and the two ends of the tank.
The columns of the tank shall consist of rolled steel joist sections or similar. Four such columns shall be provided with adequate bracing.

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

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

1050. ROCK PITCHING

Rock pitching shall consist of a free draining mixture of broken hard stone obtained from quarries approved by the Engineer which shall have a maximum size of 300 mm and which shall not contain more than 5% by weight of material which will pass 10 mm BS sieve. Between these limits the material shall be reasonably well graded so as to form a free draining blanket without large voids.

1051. ROCK LINING

Rocks for lining and bedding on concrete shall be hard, durable and free from cracks and fissures obtained from approved quarries or from materials arising from the excavations.

Rocks shall be near uniform, of the size shown, and bedded in concrete as shown on the drawings. The rocks shall break joint in every direction and fine concrete shall be worked into the joints to secure the rocks.

1052. ROOFING WORKS

Corrugated Sheet Metal Roofing
Galvanized corrugated sheet steel for roofing shall be 28 gauge with 125 mm corrugations complying with BS CP 143 Part 10 and the brand and manufacturer shall be subject to the approval of the Engineer. Aluminium roofing shall comply with BS CP 143 Part 1.

Sheets shall be fixed with side laps of one and a half corrugations and minimum 300mm end laps secured to purlins by galvanised iron bolts and iron and lead washers spaced not more than 300mm apart horizontally on each purlin.

Ridges, hips and valleys shall be 28 gauge galvanized sheet, minimum 450mm girth with roll tops and fixed with 90mm galvanized iron screws and iron and lead washers spaced not more than 300mm apart lapped 150mm at junction of lengths and with edges close dressed into corrugations of sheeting.

Valleys shall be inverted, lapped 150mm at ends of lengths close welded and securely fixed under edges of roof sheeting.

Bituminous Felt Roofing
Bituminous Roofing felt shall be in accordance with EN 13707, and shall be laid in accordance with BS 8218

Before laying roofing felt the underlying concrete surface shall have any cracks and expansion joints sealed with a bituminous patching compound. A slip membrane comprising one layer of one ply roofing felt shall be laid and adhered to the concrete at all edges.

Two under layers of two ply roofing felt shall be applied with 100 mm overlaps between strips, bonded with bitumastic compound at all edges. The overlap joints between successive layers shall be staggered to half the strip width.

A surface layer of Grey Mineralized Surface felt of an approved colour shall be laid with 100 mm overlaps, fully bonded with hot applied bitumen compound.

1053. STONE DUST

Stone dust for blinding shall be blacktrap screened to the following grading:-

Passing 10mm sieve	100%
Passing No. 4 sieve	85% -
100% Passing No. 100 sieve	5% - 25%

1054. STRUCTURAL STEEL FOR WELDED WORK

Structural steel for riveted and welded work shall comply with the requirements of SRN 125: Structural Steel, SRN 126 : The Use of Structural Steel in Building and for Welded Work, SRN 125 : High Yield Stress and High Tensile Structural Steel, High Tensile (Fusion Welding Quality) Structural Steel for Bridges, etc. and General Building Construction.

1055. STRUCTURAL STEELWORK

The whole of the structural steelwork and testing shall comply with the relevant clauses of B.S. 449. The Contractor shall include for the preparation of all shop details from the drawings supplied by the Engineer. All such details shall be approved in writing by the Engineer before the work is put in hand. Every drawing shall show the number and sizes of all rivets and bolts, complete details of welds, type of electrodes, welding procedure, whether the welds are to be made in the shop or elsewhere and any other relevant information. The Contractor shall be responsible for the accuracy of his shop details and for shop fittings and site connections.

The Contractor shall take the dimensions from the structure and he shall verify all dimensions given on the drawings before the work is put in hand.

Any damage to materials on the site due to inadequate precautions being taken during the erection of the steelwork shall be made good to the satisfaction of the Engineer's Representative at the Contractor's expense.

The fabrication and erection of the steelwork shall be carried out in accordance with Part 5 of B.S. 449.

1056. TIMBER

Timber shall be sound, well seasoned and entirely free from worm, beetle, warps, shakes, splits, and all forms of rot and deadwood. Where required, all timber shall be treated with creosote, as specified in SRN 872 : Coal Tar Creosote for the Preservation of Timber or an alternative approved timber preservative.

1057. WATER BARS

Water bars shall be "Dumbell" type and be of natural or synthetic rubber or extruded PVC. They shall be flexible, tough, elastic and durable and of dimensions detailed. They should be unaffected on contact with dilute acids or alkalis. Joints and junctions shall, when possible, be prefabricated by the manufacturer, but if made at site the manufacturer's instructions including recommended adhesives shall be followed and used. Samples shall be submitted for approval of the Engineer before use of any material.

1058. WATER FOR CEMENT TREATED MATERIALS

If water for the works is not available from the Employer's supply the Engineer's approval must be obtained regarding the source of supply and manner of its use. Water to be used with cement or lime shall be free from salt, oil, alkali, organic matter, and other deleterious substances. If the water is required to be tested, this shall be done in accordance with SRN 114: Tests for Water for Making Concrete, all to the cost of the Contractor.

1059. WATERPROOF UNDERLAY

Waterproof underlay shall consist of either waterproof paper complying with SRN 856: Waterproof Building Paper, containing approved fibrous reinforcement, or 500 gauge polythene sheeting as stated in the Bill of Quantities.

11.PLUMBING INSTALLATION

1101. WATER AUTHORITIES REGULATIONS

The internal plumbing work shall be carried out to the satisfaction of and in accordance with the regulations of the local Water Authority.

1102. RAINWATER INSTALLATIONS

Rainwater installation shall be in grey PVC pipework with 'O' ring joints.

1103. TESTING PLUMBER'S WORK

The plumbing work and sanitary fittings shall be tested at such times as the Engineer's Representative shall direct and to his entire satisfaction. Gutters and rainwater pipes shall be tested with water to satisfy the Engineer's Representative that gutters are to correct falls, pipes are unobstructed and joints are sound.

1104. SETTING OUT

The positions of all pipe runs, including joints and connections, shall be agreed with the Engineer's Representative before work is commenced.

1105. COPPER TUBES AND FITTINGS

Light gauge copper tubes shall comply with B.S. 2871 Part 1, Table X.

Fittings: Fittings and couplings for jointing pipes shall comply with B.S. 864, Part 2 for capillary and compression type A fittings.

Fixing: Tubes shall be fixed clear of walls or soffits with two piece copper spacing clips complying with B.S. 1494 Table 8d, but in metric sizes to suit tubes spaced at not more than 1.2m horizontally and 1.5m vertically for 15mm diameter pipes 2.0m horizontally and 2.5m vertically for 22mm and 28mm diameter pipes.

1106. PLASTIC PIPES, FITTINGS AND ACCESSORIES

uPVC soil and ventilating pipes and fittings shall comply with B.S. 4514. Waste pipes and fittings shall be modified unplasticised polyvinyl chloride (MuPVC). Waste traps shall comply with B.S. 3943. Balloon gratings shall be plastic coated steel wire.

1107. SLEEVES

Where sleeves are required for pipes passing through concrete or blockwork they shall be of galvanized steel heavy gauge tube of sufficient diameter to give a space of 3mm all round the pipe.

1108. CHASING

Chasing in load-bearing walling for pipes, etc., is to be kept to a minimum size of cut and the positions and runs of chases are to be approved by the Engineer before any cutting is commenced.

1109. PIPEWORK GENERALLY

Pipes shall be in the maximum lengths possible to avoid unnecessary jointing and fixed to sufficient falls to prevent air locks and to enable the system to be drained down.

1110. BRASSWORK

Ball Valves: Piston type ball valves shall comply with B.S. 1212, Part 1 for high or low pressure as described. Floats to break feed cisterns shall be copper type complying with B.S. 1968, Class C.

Bib-taps shall comply with B.S. 1010 and shall be of brass with fixed jumpers, chromium plated and colour coded for hot and cold.

Pillar valves shall comply with B.S. 1010 and shall be of brass with fixed jumpers, chromium plated and colour coded for hot and cold.

Stop valves shall comply with B.S. 1010 and shall be of brass with crutch handles.

1111. CISTERNS

Storage cisterns and break feed cisterns shall be galvanized steel cisterns complying with B.S. 417, Grade A.

1112. SANITARY FITTINGS

Sanitary fittings shall be manufactured from glazed vitreous china complying with the requirements of B.S. 3402. They shall be supplied by an approved firm and shall pass the requirements of the local Water Authority.

12.PLASTERWORK AND OTHER FLOOR, WALL AND CEILING FINISHINGS

1201. GENERAL

All branded materials shall be delivered in the manufacturer's packages bearing the manufacturer's name and the name of the material concerned. Cement, lime, plaster etc., shall be stored separately off the ground in dry conditions. All surfaces shall be properly prepared for plastering, rendering and screeding and brushed or cleaned free from dust and all traces of efflorescence and contamination removed. Concrete surfaces shall be thoroughly cleaned free from all traces of mould oil or other formwork coatings and hacked to provide a key. The prices for all pavings and plastering, etc., shall include for hacking concrete surfaces and for raking out joints of walls 12mm deep and for cross scoring undercoats to form a proper key.

Surface to receive plastering, rendering, screeding etc. shall be wetted sufficiently in advance to ensure the correct conditions for adhesion. Undercoats shall be thoroughly scratched to allow for keying and allowed to dry sufficiently before application of further coats. Dubbing out shall be in the same mix as the subsequent coat and shall not exceed 20mm in thickness in one application. As required, all cement pavings and plaster shall be kept continually damp in the interval between application of coats and for seven days after the application of the final coat.

1202. METAL LATHING

Metal lathing shall be light galvanized expanded metal weighing not less than 1.2 kg. per square metre and complying in all other respects with B.S. 1369.

1203. CEMENT

Cement shall be Ordinary Portland Cement and shall comply with KS 02-21. White and coloured cements shall comply with KS 02-21 and shall be obtained from an approved manufacturer.

1204. SANDS

Sand for cement and lime shall comply with B.S. 1199, Table 1 for undercoats and Table 2 for finishing coats. Sand for floor screeds shall comply with B.S. 1199, Table 1.

1205. LIME PUTTY

Lime putty shall be prepared from hydrated lime complying with B.S. 890, Table 2. Hydrated lime shall be added to water, stirred to a creamy consistency and left to mature for at least sixteen hours before use. Alternatively, ready slaked lime may be obtained from an approved manufacturer. The lime putty shall be protected from drying out.

1206. PLASTICISERS

Plasticisers shall be of the resin type and shall be used only with the approval of the Engineer's Representative in accordance with the manufacturer's instructions.

1207. WATER PROOFERS

Water proofers shall be approved integral water proofers and shall be used in accordance with the manufacturer's instructions.

1208. ANGLE AND CASING BEADS AND RENDER STOPS

Galvanised steel angle and casing beads and render stops shall be as manufactured by “Expamet” or other equal and approved.

13.TILE WORK

1301. GLAZED CERAMIC WALL TILES

Glazed and eggshell ceramic wall tiles shall comply with B.S. 1218 and shall be of the colours described. Samples of tiles shall be submitted to the Engineer's Representative for approval.

1302. ADHESIVE

Adhesive for fixing wall tiles shall be approved adhesive.

1303. FIXING WALL TILES

Tiles shall be wiped clean and fixed dry with the approved adhesive all in accordance with manufacturer's recommendations with straight joints 1.6mm wide, pointed in white cement.

1304. CERAMIC FLOOR TILES

Ceramic floor tiles shall be fully vitrified clay tiles complying with B.S. 1286 and having a water absorption not exceeding 0.3%.

1305. LAYING FLOOR TILES

For laying of floor tiles the surface of the compacted bedding shall be spread with a 3mm thick cement and sand (1:1) slurry. Floor tiles shall be wiped clean and laid dry, in a square pattern with 3mm wide joints and tapped into the grout. Pointing shall be in an approved proprietory tile grout, tinted to match floor tiles.

1306. FIXING METAL LATHING

At junctions of blockwork and concrete where rendering continues over both surfaces a 100mm wide strip of expanded metal lath shall be fixed, centred on the joint.

1307. FINISH

Cement-lime-sand undercoats shall be allowed to dry out thoroughly before a further coat is applied and scratched to provide an adequate key for the next coat. The finishing coat shall be finished with a steel float. A neat cut shall be made with the edge of the trowel through all coats of the wall plaster at junctions with concrete columns and soffits.

1308. INTERNAL RENDERING

The internal rendering on concrete block panels shall be two coat work, total 20mm finished thickness. The undercoat to be 1:1:5 cement, lime putty, sand by volume, 9mm to 12mm thick and scratched for key. The finishing coat to be 1:1:6 cement, lime putty, sand by volume, 6mm to 9mm thick, trowelled smooth. At junctions of panels to concrete columns and beam soffit, finish the rendering with a clean trowel cutting through both coats of rendering.

1309. EXTERNAL RENDERING (TYROLEAN)

The external rendering on concrete blockwork and outer face of in-situ concrete frame shall be two coat work, total 15mm finished thickness. Clean and prepare block and concrete surfaces, shot pin metal lath strip 100mm wide at concrete/blockwork junctions and apply undercoat 10mm finished thickness of 1:1:6 cement, lime putty, sand by volume, floated smooth. The finishing coat shall be approximately 6mm thick off white Culamix Tyrolean open honeycombed texture machine applied to the required

thickness by skilled operatives strictly in accordance with the manufacturer's recommendations, manufactured and supplied by Blue Circle Industries Ltd., agents in Kenya, Kencem, P.O. Box 14267, Nairobi, Kenya or other approved alternative. The undercoat surface shall be sound and clean and free from any loose material. All window and door frames shall be protected by suitable masking.

1310. EXPANSION JOINTS

Expansion joints in clay ceramic tile flooring shall be 6mm wide x 50mm deep, unless otherwise described, formed with 6mm wide x 38mm deep butyl rubber or other equal and approved compressible strip pointed with 6mm wide x 12mm deep polysulphide compound to match colour of tiling. All surfaces of concrete or screed in contact with the butyl rubber shall be primed.

Expansion joints shall be formed at perimeters and at not less than 4.5 metre centres both ways in the tiled areas.

1311. PREPARATION

Concrete floors to receive screeds shall be raked where necessary to remove concrete, plaster or mortar droppings and well brushed to remove all loose particles and dirt. Concrete floors shall be well wetted before the screeds are laid.

1312. POLISHED TERRAZZO

Polished terrazzo shall be laid by an approved Sub-Contractor and shall consist of a screed or backing coat and a finishing coat of "Snowcrete" and marble chippings (1:2) mixed with "Cemantone No. 1" colouring compound in accordance with the manufacturer's instructions in the proportions of 10 lbs. compound to 100 lbs. cement. Overall thicknesses are to be as specified.

The finishing coat shall be a minimum of 12mm thick for pavings trowelled to a smooth and even finish and well rubbed and polished with carborundum.

14.PAINTING AND DECORATING

1401. PAINT AND PAINTING

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

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

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

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

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

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

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

All paints described as oil paint shall be alkyd paint.

No painting on exterior work shall be carried out in wet weather or upon surfaces which are not thoroughly dry. Painting shall not proceed in dusty conditions. Each coat of paint shall be thoroughly dry and shall be rubbed down with glass paper before a subsequent coat is applied. Adequate care must be taken to protect surfaces of paintwork, still wet.
Lead based priming paints for steelwork shall conform to B.S. 2521 and 2523.

1402. PREPARATION

Copper pipes shall be washed with soap and water, roughened with abrasive paper and washed with white spirit.

Metalwork - remove all scale from unprimed iron and steelwork, degrease using proprietary solution compatible with paint finish, remove all dirt and rust by brushing with a steel wire brush. Clean all steel delivered primed, of dirt and dust and touch up any damage to primed surfaces in transit or erection.

Hardwood - rub down and brush off all dirt and dust, stop any holes or other imperfections with stopping tinted to match pigment finish.

1403. PROTECTIVE DECORATIVE FINISH

The protective decorative finish on hardwood joinery shall be PX65 (Pinotex) and Holdex as manufactured and supplied by Sadolins Paints (E.A.), or other equal and approved finish.

External frames and doors shall be treated with two coats PX65 (Pinotex) Pigmented before fixing and one coat PX65 (Pinotex) Top Coat after fixing.

Internal frames and doors shall be treated with two coats PX65 (Pinotex) Pigmented before fixing and one coat after fixing and finished with two coats of Holdex, Silk Matt Interior Lacquer.

Application shall be strictly in accordance with the manufacturer's recommendations.
Not more than three months should separate the initial (before fixing) and final (after fixing) coats.

1404. RENDERED PANELS

The internal rendered blockwork panels shall be painted with two coats Sandtex Matt resin- based surface coating or other equal and approved coating.

Rendered wall surface shall be cleaned down and Sandtex coats laid on by brush or roller in accordance with the manufacturer's recommendations. Spraying wall surfaces will not be allowed.

1405. IRONMONGERY FURNITURE

The rates for painting shall include for taking down and refixing ironmongery furniture, kicking plates etc., as necessary.

15.ROADS AND FOOTPATHS

1501. PREPARATION OF ROAD FORMATION

After excavation or filling has been completed the road formation shall be shaped to the required contour and compacted with an 8 - 10 tonne roller.

If any soft places develop in the formation during compaction they shall be excavated to such depths as the Engineer may direct, refilled with hardcore or other approved granular material, levelled and re-compacted before the sub-base is laid.

1502. MURRAM SUB-BASE

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

The murram sub-base shall be of the thickness as shown on drawings or stated in the Bill of Quantities.

The sub-base shall be evenly spread and compacted using an 8-10 tonne roller for road construction and a 2-4 tonne roller for footpath construction. The Contractor will be required to maintain the selected material at its optimum moisture content to achieve maximum compaction. The roads and footpaths shall be finished to the grades and levels shown on the drawings.

1503. WATER-BOUND MACADAM BASE

The base shall consist of crushed building stone mechanically laid in one or more separate layers, so as to give a total compacted thickness as shown on the drawings, or stated in the Bill of Quantities. The first layer shall be placed to produce a thickness of 75mm to 150mm after compaction as specified. Where a greater thickness than 150mm of base is specified the material shall be laid in separate layers each not less than 75mm or more than 150mm in thickness after compaction.

The stone shall have the following gradings:-

B.S. Sieve Size	% by Weight Passing
5 in. (125mm) ring	100
3 in. (75mm)	25 - 80
1.5 in. (38mm)	0 - 20
3/4 in. (20mm)	0 - 5

Alternatively, a stone base may be placed by hand. In this case the first stones in each layer, which shall be of a cubical nature, shall be placed to the approximate height of the layer. When an area has been covered in this way a second placing of stones of smaller size shall be positioned by eye in the spaces between these first placed, and wedged home by hammering. A third placing of stones shall follow the second and so on until in the opinion of the Engineer the voids are sufficiently filled to permit compaction.

Thorough watering shall be carried out at all stages of compaction. Initial compaction shall be with a

light roller. The surface shall then be blinded with quarry dust so as to fill the interstices completely and again rolled, this time using a heavy roller. The base shall then be well watered and brushed and permitted to dry. Further rolling with a heavy roller, blinding with quarry dust, watering and brushing shall be carried on until the whole presents a homogeneous surface and no movement is visible under the action of the heavy roller. On completion of the base, and before any surfacing is laid, the finishing surface shall be maintained free from potholes, ruts and undulations, irregularities, depressions, loose material or other defects, and shall remain true to cross-section, line and level.

1504. ROLLED ASPHALT HOT PROCESS WEARING COURSE

Rolled asphalt wearing course shall be made and laid in accordance with British Standard 594: Rolled Asphalt (Hot Process) and the thickness after compaction shall be as shown on the drawings or stated in the Bill of Quantities. Except where impracticable, the rolled asphalt shall be laid using an approved paver.

Where a base course has been used as part of the surfacing, the wearing course shall be laid thereon as soon as practicable, care being taken that the latter is thoroughly clean. In any case the wearing course should be laid within 3 days of the laying of the base course, unless the Engineer allows otherwise, and no construction or other traffic shall be allowed on the base course.

1505. BITUMEN MACADAM WEARING COURSE

Bitumen macadam wearing course shall be made and laid in accordance with British Standard 1621: Bitumen Macadam with Crushed Rock or Slag Aggregate, using the appropriate Table and Section(s) thereof, other than those for Dense Bitumen Macadam, and nominal size of aggregate all as shown on the drawings or stated in the Bill of Quantities. Except where impracticable the bitumen macadam shall be laid using an approved paver. The maximum mixing temperature for straight run bitumen of penetration 85-100 is 155 degrees centigrade. For other penetration bitumens the mixing temperature shall be as determined by the Engineer.

1506. COMPACTION AND SURFACE FINISH

As soon as rolling can be effected without causing undue displacement of the material, and while the material is above the minimum temperature stated in Table 6.3, it shall be uniformly compacted by an 8-10 tonne roller having a width of roll not less than 18 inches.

1507. PREPARATION OF THE BASE FOR SURFACING OR SURFACE DRESSING

Before any binder or coating material is applied to a base the latter shall have been freed from all extraneous material by brushing with mechanical sweepers or stiff brooms.

Macadam or murram bases shall normally receive a priming coat in accordance with the following clause.

Concrete, bitumen bound or rolled asphalt bases shall normally receive a tack coat in accordance with the following clause.

1508. PRIME COAT AND TACK COAT

When a base is to be sealed before surfacing by means of a prime coat, the surface shall first be prepared in accordance with the preceding clause.

Unless otherwise stated in the Bill of Quantities or ordered by the Engineer, the prime coat material shall be bitumen grade M.C.O. at a rate of application of 1.2-1.5 lit./sq.m. It shall be applied with a mechanical bitumen distributor complying with the requirements of British Standard 1707: Binder Distributors for

Road Surface Dressing.

The prime coat shall be cured for 48 hours. This period may be relaxed at the discretion of the Engineer who shall be informed and shall give his consent before any surfacing works are commenced.

The Contractor shall not permit traffic to run on a prime coat. Where this is unavoidable the Engineer shall order an application of medium sand at a rate of 6 kg./sq.m which item shall be measured and paid for separately.

Where adhesion on an existing surface is to be improved before surfacing by means of a tack coat, the surface shall first be prepared in accordance with the preceding clause.

Unless otherwise stated in the Bill of Quantities or ordered by the Engineer, the tack coat material shall be approved bitumen emulsion in accordance with British Standard 434: Bitumen Road Emulsion containing not less than 55% of bitumen. It shall be mechanically applied at a rate of 0.38 - 0.43 lit./sq.m.

The tack coat shall be allowed to cure to a tacky condition and the Engineer's consent obtained before any surfacing works are commenced. Any ponding which has occurred must be brushed out to bring the coverage within the limits specified.

The Contractor shall not permit traffic under any circumstances to run on a tack coat.

1509. ROLLING OF SURFACE MATERIALS

The type and weight of roller to be employed on each course of surfacing shall be approved before hand by the Engineer. Notwithstanding this, the Engineer may call for a certified weighbridge ticket in respect of any roller at any time.

Roller wheels shall always be clean and even. An adequate water tank shall be provided together with a fully operating roller sprinkler system. The roller shall be operated by a person fully trained and experienced in rolling technique.

Rolling shall be generally carried out in a longitudinal direction, working from the edge of the carriageway to the crown or, in the case of a super elevated carriageway, from the low to the high side. The second pass should be precisely on the path of the first, before the roller shifts transversely. Heavy drive wheels should approach the freshly laid material. Reversing should be carried out slowly and smoothly and the reversing points staggered across the carriageway to avoid any wave effect. Rolling should be continued until all rollmarks are eliminated and there is no perceptible movement under the roller wheels.

Idle standing on freshly laid material is not permitted.

If the total surfacing to be compacted exceeds 3,300 sq.m. per day, the Contractor shall provide a second roller.

In confined areas where normal rolling is not possible, mechanical tamping will be permitted. The tampers must be employed systematically to give a smooth "as-rolled" finish.

No traffic will be permitted on a surfacing course until it has been compacted and in the opinion of the Engineer has acquired a sufficient set.

1510. TRAFFIC ON NEWLY CONSTRUCTED ROADS

The Contractor will not be permitted to use a new carriageway at any stage of construction without the written permission of the Engineer's Representative.

Notwithstanding any conditions which the Engineer's Representative may stipulate at the time of giving his permission, the Contractor will be solely responsible for maintaining the new carriageway, keeping the surface clean and for making good at his own expense any damage or wear so caused.

1511. LAYING KERBS, CHANNELS AND EDGING BLOCKS

Kerbs, channels and edging blocks shall be bedded true to line and level in cement mortar on a concrete foundation Grade 15. They shall be haunched with concrete Grade 15. The foundation and haunch shall be laid before the approved sub-base is laid to the dimensions shown on the drawings.

1512. CONCRETE BLOCK PAVINGS

The precast concrete blocks have to be manufactured to the following requirements:-

i) Depth of block to be 60mm and 80mm.

ii) The concrete used shall have a maximum aggregate size of 20mm, high workability, and shall be designed to have a 20 day characteristic cube strength of 45 N/sq.mm.

iii) To ensure that the surface does not polish but retains a micro texture to give good low speed skidding resistance, sands containing more than 25% acid soluble material must not be used.

iv) To ensure interlock between blocks, they must be manufactured to accurate dimensions, which allow them to be laid with only small spaces between the joints. When laid, the spaces between blocks should not exceed 2 to 3mm.

1513. LAYING OF BLOCKS

The blocks should be laid in such a way so as to develop interlock. The surface course comprises closely fitting paving blocks, the spaces between them being filled with dust and sand particles.

The finished surface level shall be within 5mm of the design level. The maximum deformation within the completed surface measured by a 3m straight edge placed parallel to the centre line of the road in parts of the carriageway where vertical curves necessitate a greater deviation.

The level of any two adjacent blocks should not deviate by more than 2mm.

1514. LAYING COURSE

The laying course shall consist of 40mm sand as specified containing not more than 3% of silt and clay by weight, and, with no more than 10% retained on a 5mm sieve. It is spread to give a thickness when compacted of 40mm. The profile of the uncompacted sand should be similar to that of the final surface. The required thickness of uncompacted sand forming the laying course will depend upon its moisture content grading, and degree of pre-compaction. The laying course sand needs to be spread to a greater depth than the target compacted depth of 40mm. The amount of surcharge will be of the order of 10 to 15mm but the exact value is best determined by trial. To avoid any need to adjust the surcharge during construction, it is helpful to keep the sand grading and moisture content sensibly constant.

Once spread the sand should be screed smooth to level. For roads less than 4.5m wide, the kerbs may be used as screeding guides, but on wide pavements, it is necessary to set temporary screed rails for striking off the laying course. During spreading and screeding, operatives must not stand in the sand, otherwise uneven pre-compaction will occur causing

irregularities in the final road surface. To minimise the risk of disturbance, it is advisable to avoid screeding sand long distances in front of the block laying face.

1515. CUTTING BLOCKS

Awkward shapes at edges or obstructions, like gulleys manholes are filled by cutting blocks with a block splitter or by using a bolster chisel and hammer.

1516. VIBRATION

When the laying of concrete blocks has been completed, then blocks should be vibrated with a plate vibrator. The vibrator should have a centrifugal force of 0.35 to 0.50 sq.m. A frequency of 75 to 100 Hz is recommended.

The required number of passes of the plate depends upon a variety of factors and is best determined by site trial. It should be sufficient to provide an even riding surface and prevent vehicles from causing further compaction. Normally two or three passes will suffice. Vibration should not be carried out within about 1m of unrestricted blocks; on the other hand, as little surface course as possible should be left unvibrated overnight.

Finally, sand should be brushed over the surface and two or three further passes of the vibrator made, to complete interlock and fill the joints.

As soon as vibration has been completed, the road can be used.

1517. PREPARATION OF FOOTPATH FORMATION

After the excavation of filling has been completed as specified the footpath formation shall be regulated to an even and uniform surface, and compacted with a roller weighing not less than 2.5 tonnes.

If any soft places develop in the formation during compaction they shall be excavated and backfilled with approved granular material, levelled and re-compacted.

1518. PRECAST CONCRETE PAVING

Precast concrete paving slabs shall be to B.S. 368 : 1971 and shall be laid with 1:3 lime mortar using five pats not less than 150mm diameter for each slab. They shall be laid at a level not exceeding 4mm above the top of the kerb or concrete edging. The joints shall be thoroughly cleaned out and grouted with cement mortar well brushed in and flushed off. No cracked or broken slabs shall be used.

16.TESTING OF MATERIALS AND WORKMANSHIP

1601. APPARATUS REQUIRED FOR TESTING ON SITE

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

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

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

Medium mesh wire cloth 3mm.

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

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

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

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

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

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

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

h) Precision Ultrasonic Thickness Gauge suitable for measuring pipe wall thicknesses

i) Coating Thickness Gages for all Metal Substrates, using magnetic and eddy current principles

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

17.MECHANICAL WORKS

1701. GENERAL

1701.1. Materials

Any non-metallic materials such as may be employed for bellows, packing or sleeves, coatings or linings etc. liable to contact with potable water shall be approved for the purpose by a recognized approval body.

i) Materials in Contact with Sewage

Materials in contact with sewage shall be suitable for the environment but particularly all bronze materials shall be true bronze (i.e. zinc free) alloys.

ii) Indicator Gauges

All gauges shall be constructed with non-corrodible metal cases and stainless steel bezels. They shall be located to enable easy readings by the plant operator and mounted to preclude damage due to vibration. The cases shall be at least 50mm diameter, unless otherwise specified, scaled in metric units and normally ranged over a 240º arc from zero to 20% - 40% above the system designed operating value for full load conditions; except where finite limits exist, e.g. level/contents gauges which shall be ranged 0-100%, or where restricted ranges are specified.

A schedule of gauges shall be provided for approval, detailing arrangements, scale ranges, designation label inscriptions and any alarm contacts.

Labels shall be securely attached on or adjacent to each gauge and groups of any such instruments shall be of matching appearance and approved layout.

Pressure gauges shall be of the Bourdon tube or diaphragm type. Each gauge shall incorporate a surge damping device and be fitted with its own stainless steel isolating cock.

Pressure gauges incorporating transducers for remote monitoring shall be damped to provide a steady output. The pressure at the tapping point shall give a direct indication on the gauge as well as driving the transducer. Any alarm contact settings shall be independent of the transducer function and nether shall interfere with the direct gauge indication.

Temperature gauges shall be of a type suitable for the application with the sensing element mounted within a thermal well. Where specified, the maximum working temperature under full load conditions shall be marked by means of a preset red pointer.

Pumping station water pressure gauges shall have a dial diameter of not less than 100mm and be calibrated in metres head. The gauges shall be uncorrected for datum and show actual pressure at the tapping point. The label bearing the designation given in the gauge schedule shall include the Ordnance Datum level of the tapping point.

Pump delivery and station delivery pressure gauges shall be mounted at a convenient height for reading on a gauge board of varnished hardwood, 20mm marine plywood or equivalent non-corrodible material with stainless steel capillary pipework, having an isolating cock at each end connecting the pressure tapping bosses and shall be adequately supported.

iii) Fasteners

All bolts, nuts, and studblots, including those required for installation at terminal points to existing equipment, shall be provided by the Contractor and shall have metric threads to BS 3643.

After tightening, the minimum engagement of the thread shall equal the thickness of the nut. The projection of the head beyond the outer face of the nut shall not exceed one quarter of the outside diameter of the thread. In no circumstances shall galvanised or coated bolts be shortened by cutting.

iv) Washers shall be provided under all Nut and Bolt Heads

All fastenings and accessories in contact with the process water shall be of stainless steel, cadium plated mild steel or other corrosion resistant material subject to the approval of the Engineer. All bolts, nuts, screws, washers and other fixings for anchoring the plant to walls, floors, ceilings, etc. shall be of corrosion resistant material or shall have a protective surface treatment to the approval of the Engineer.

All bolts in inaccessible positions shall be secured by either self locking nuts, spring washers and nuts, or castle nuts with split pins. Fasteners associated with items requiring removal during routine maintenance shall be of stainless steel. All other items shall be sheradised or hot dip galvanized in matched condition.

All holding-down or foundation bolts shall be supplied and shall be complete with hexagon nuts and washers. Bolts of steel round bar formed into a loop at one end are not acceptable.

v) Fastenings to Concrete or Masonry

Anchor bolts for the fixing of small items shall be of the torque-expanded type of approved make, installed strictly in accordance with the manufacturer's instructions. The size of hole required in the Civil work shall not exceed 38mm.

Where the base material will not withstand the expansion stresses imposed by the torque-expanded type or where the highest degree of resistance to vibration is required an approved type of chemically bonded anchor bolt may be used.

The minimum distance from any concrete edge shall be 100mm for expanding type fixings and 75mm for embedded bolts.

vi) Baseplates

Separately mounted items of plant which are required to maintain an accurate alignment shall be mounted on a common baseplate, together with all associated items and guards.

The baseplate shall be of rigid construction, machined on all mating surfaces and drilled for foundation fixings. Machined datum faces shall be provided and leveling facilities incorporated in the underside.

Provision shall be made for the easy removal of any section of the drive and positive re-alignment using dowels or other approved means. Shims and packings shall be kept to a minimum and clearly identified for re-assembly.

All drain points on the assembled plant are to have easy access and drain piping shall extend beyond the baseplate.

vii) Provision for Handling

Suitable provision approved by the Engineer shall be made by the Contractor to facilitate the handling of all items in excess of 36kg.

Any item weighing one tonne or over and which may be required to be lifted during operation and maintenance shall be appropriately marked with its weight.

viii) Protection of Moving Parts

All moving parts where accessible to operational personnel shall be protected and guarded to meet relevant regulations. All guards shall be designed to facilitate easy removal.

ix) Balancing

All rotating parts of the machinery shall be statically and dynamically balanced unless otherwise agreed in writing by the Engineer. The complete rotating assembly shall be designed such that any critical speeds are outside the duty running speed range of the machine.

x) Lubrication

Any components requiring manual lubrication shall be provided with greasing nipples of an approved type mounted on a panel and identified.

A remotely mounted electrically operated lubricator of approved type shall be provided to serve components, if any, requiring continuous lubrication by external mechanical means.

The lubrication tubes, if any, shall be of approved material suitable for high pressure use. The Contractor shall include for all grease and oil required for testing at works and site.

The first filling after tests shall be provided by the Contractor who shall submit details of his recommended lubricants, which shall be available from any of the major oil companies, for approval by the Engineer.

All bearing surfaces shall be properly charged with grease before the plant is operated.

xi) Nameplates and Labels

Instruction plates, name plates and labels shall be provided for all items of the plant giving particulars of duty, size, serial number and full information for identification and operation. Their construction and engraving shall be to the Engineer's approval.

xii) Plant References

After final painting, all plant items shall be identified by a unique reference character as detailed on the specification drawings or otherwise specified. Such references to be affixed in a prominent position on the plant body with characters not less than 100mm high or as otherwise specified. Characters shall be bold capital letters and/or numerals. The abbreviation 'No' shall not be used.

Unit references shall include any associated main and auxiliary drives shall follow a logical sequence bases on layout or history. In any particular installation, a set of similar duty drives where any number of units may run shall be suffixed 1, 2, 2,3, 4 etc. whereas alternative drives for the same duty where only one unit may run (i.e. duty/standby) shall be suffixed A & B.

xiii) Tools and Tackle for Maintenance

The Contractor shall supply a complete set of any special tools and other equipment necessary for the dismantling, re-erection and adjustment of the plant.

The tools provided shall be in new condition, adequately labeled as to their use and contained in stout and suitable padlocked boxes. The Engineer's instructions as to who shall be the recipient of the tools shall be sought before delivery is made.

Any special slings required shall be provided and clearly marked by embossed labels to show safe working loads. Test certificates shall be provided where applicable.

xiv) Locks and Keys for Mechanical Plant

All locks of the same size shall be of the same type as manufacture but having different keys.

Three keys shall be provided for each lock.

Each key shall have prominently attached to it an embossed brass label stating the following:

- Key number;
- Location of lock/Item of equipment.

xv) Noise Level

All plant shall run without undue vibration and with the least practicable amount of noise.

Vibration levels shall not exceed those set out in ISO 2372 for the particular type of equipment.

Any items of plant which produce a noise level exceeding 65 dB (A) at 3 metres shall be listed by the Tenderer. It shall be deemed that all items of plant not so listed have a noise level of less than 65 dB (A) at 3 metres.

To meet the environmental requirements, the Contractor shall provide all necessary equipment to meet the following conditions, based on the site layout shown on the specification drawings and with 75% of the plant running simultaneously:

- the noise level generated at the site boundary by any new plant shall not exceed that generated by the existing plant;
- the noise level at 100m from the source does not exceed 65dB (A);
- the noise level in the building (10m from the source) does not exceed 80 dB (A);
- the noise level in the plant room (5m from the source) does not exceed 80dB (A);
- warning notices shall be provided at all entrances to rooms where the noise level will exceed 75 dB (A).

xvi)Frost Protection

The plant shall be adequately protected against damage from freezing where appropriate, using an approved means of insulation.

Particular attention shall be given to pipework, pump casings, etc. and any part of the plant and equipment likely to stand for periods charged with static water.

Where lagging is used, it shall be suitable for outside installation and completely impervious to all weather and atmospheric conditions on the works. Lagging materials containing asbestos shall not be used.

The lagging shall be sectional and easily removed for maintenance purposes. Joints shall be sealed together with an approved waterproof adhesive tape.

Areas where lagging may be vulnerable to damage shall be suitably protected by an approved means.

xvii) Corrosion Protection

Where dissimilar metals are in contact or close proximity and corrosion may occur through electrolytic action or differences in electrical potential, protection shall be afforded by electroplating, suitable gaskets, cathodic protection or other means approved by the Engineer.

Chromium plated parts shall not be used on sewage works or in any other damp or corrosive atmosphere.

All surfaces shall be adequately protected in transit, and any damage shall be removed immediately on off-loading and on completion of erection.

After cleaning and inspection but before the plant leaves the Contractor's works, the machined surfaces of steel and ironwork shall be covered with preserving fluid of an approved type, or otherwise protected to the Engineer's satisfaction.

All external steel screw fittings shall be supplied in the galvanized condition, stainless steel, or sheradised to comply with BS 4921, Class 1 or Class 2 with passivation treatment.

xviii) Surface Preparation and Painting

The whole preparation and paint system shall be suitable for operating environment specified and a painting schedule giving details of preparatory treatment, types of paint, number of coats and method of application shall be submitted with the Tender. (See Particulars of Plant).

Proprietary items may be used in their standard finish subject to the approval of the Engineer. For specified applications, adequate supervision shall be provided for all stages of preparation, application and testing.

All steelwork shall be protected in accordance with BS 5493 and based on a 'long' time to first maintenance. The exterior environment shall be regarded as 'polluted inland' (Table 1 Pt. 2) and the interior environment shall be regarded as 'frequently damp' (Table 1 Pt. 7) unless otherwise specified. Items below water level or subject to immersion shall be treated as Table 1 Pt 8.

After all machining, forming and welding has been completed, all steelwork surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contaminations prior to any painting.

The system proposed shall be abrasion resistant and conform to the following typical requirements.

Preparation of steelwork at the works shall be either:

- Hot dip galvanized to BS 729 with a median thickness of 85 microns (0.0034"); or
- Grit blasted to BS 7079 Grade SA 2.5 and zinc sprayed within 4 hours to BS 2569 Part 1 to a thickness of 125 microns (o.oo5") followed by one coat of approved etch primer.

Typical finishes (with compatible primers) based on BS 5493 are given below: Steelwork and ferrous castings exposed above water/sewage level.

Either high build micaceous iron oxide or chlorinated rubber to give a minimum total dry film thickness of 300 microns, or one coat of two pack epoxy primer and further coats of epoxy paint to give a total dry film thickness of 270 microns;

xix) Steel Work below Water/Sewage Level

Either epoxy system as above or coal tar epoxy paint system to give a minimum total dry film thickness of 450 microns;

Ferrous castings and fittings without substrate below water level.

Coal tar epoxy paint system to give a minimum total dry film thickness of 450 microns. These coatings shall be subject to the Holiday Test.

The surface of all non-ferrous parts usually painted shall be cleaned, rubbed down, stopped, filled and given one priming coat of paint.

Anti-corrosion coatings used for any steel or iron used in pipework, pumps, valves, etc. in contact with potable water, shall either be a compatible bitumen material to BS 3416 or a polymeric anti-corrosion coating complying with Water Industry Specification WIS 4-52- 01.

Any damage occurring to any part of a painting scheme shall be made good to the same standard of protection and appearance as that originally employed. Any finish coat applied onsite shall be considered for decorative purposes only.

Manufactured articles to be galvanized shall be hot dip galvanized after complete fabrication and no bending, cutting, drilling, riveting or threading shall be permitted after galvanizing.

The care of galvanized articles when transporting, storing and erecting them shall be in accordance with the recommendations of BS 729. The renovation of small areas of damaged coating not exceeding 40mm^2 shall be in accordance with Appendix D of BS 729 and subject to the Engineer's approval.

xx) Paint Colours

The colours of the primer, intermediate and finishing coats of a paint system shall be easily distinguishable from each other, and the materials used shall be suitable for the method of

application and preferably be supplied by one manufacturer who shall ensure that all coatings are compatible.

The final colours and finish for the equipment shall be as specified in the Particular Specifications, or as is usual for the location, unless otherwise advised.

1702. PUMPS

1702.1. Pump Duty

Pumps shall be of the type specified and arranged as indicated in the Particular Specifications and Drawings. They shall be designed to give specified output against all losses including those relating to the pump.

The Contractor shall match his pump characteristics to the pipe system network to achieve high pump efficiency and reliability.

Each set must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitation or overload under all operating conditions within the system characteristics given.

The pump section and arrangement shall be such as to ensure that the head available exceeds the N.P.S.H. requirements of the pump under all operating condition.

Where the system and pump characteristics are such as to give rise to the possibility of surge in the pipeline with consequential damage, a surge investigation shall be undertaken if the results of the investigation show that there is a problem. Measures shall be proposed by the Contractor to alleviate the problem. These measures shall be agreed with the Engineer. Centrifugal pumps shall be capable of withstanding without detriment, reverse rotation to a speed that would occur if the pump were to stop when the differential head was at a maximum and the delivery and/or non-return valve failed to close.

For sewage pumps the ability to operate with the maximum reliability is of prime importance, with efficiency being a secondary consideration. The pump shall therefore operate without clogging, being designed to pass a sphere of 125 mm diameter where the size of the delivery mains permits. Whilst the pumps shall be designed to meet a specific duty they shall also be capable of operating over the duty range specified for prolonged period and for standing idle for long periods without attention as in the case of storm pumping.

1702.2. Centrifugal Pump Casings

Pump casings shall be of the volute type and shall be capable of withstanding all pressures which may be produced due to operating pressure surges.

Particular attention shall be paid to the wear characteristics of the pumps. In the case of sewage pumps, due to the presence of grit in the sewage water, could be appreciable.

The pump design shall ensure that alignment is maintained between the various assemblies by recesses, spigots and dowels and shall be such that all components liable to wear can be replaced.

Components shall be permanently marked with the manufacturer's number and where dowels are not used, permanently marked for correct assembly. The pump casing and the pump impeller should normally have detachable wear rings.

The casings of the pumps shall be of a suitable grade of close-grained grey cast iron or nickel iron and have flanges to match the specified pipework.

The waterways through the pumps shall be smooth in finish and free from recesses and obstructions.

Sewage pump casings shall be of substantial construction to give long life under abrasive conditions and suitably stiffened to withstand shock due to solids in suspension. Inspection holes shall be provided in any section bend and in the pump casing above the impeller for access to facilitate the clearance of obstructions. The inspection hole covers shall be shaped to conform to the interior profile of the waterway when in place and shall be fitted with starting screws where necessary.

1702.3. Impellers

Impellers shall be securely fitted to pump shafts in such a manner to prevent them becoming loose or detached when the pump is in operation, or when rotating in the reverse direction, either by liquid flow or motor rotation.

The impellers and guide vanes (if any) shall be manufactured from a suitable material, accurately machined and smoothly finished to minimize hydraulic losses.

The rotating elements shall be statistically and dynamically balanced before final assembly. The impeller shall be readily withdrawable from the pump casing without the need to disconnect pipework.

For sewage pumps the impeller shall be of the open type with the inlet ends of the vanes being of bulbous design and the impeller passages being as large as possible consistent with good performance.

The inlet ends and surfaces of the vanes shall be dressed to give a smooth finish to prevent fouling by rages and fibrous matter within the pumps.

Impellers for both sewage and storm water pumps shall be of the non-shrouded type, constructed normally of close-grained grey cast/nickel-iron, and designed to exclude gritty matter from the shaft and gland.

Clearance at the eye rings and wear plates shall be kept to a minimum, and where it is found necessary to cut back the impeller this it to be done on the vanes only.

1702.4. Pump Shaft

The pump shaft shall be of high tensile or stainless steel adequately sized, with good fatigue, shock load and corrosion resistance. The duty speed range shall be well below the first critical speed of the shaft. Where a change in diameter of the shaft occurs the shoulder shall be radiussed or undercut to the appropriate BS to reduce stress concentration.

The shaft shall be complete with easily renewable steel protecting sleeves at glands and bearings.

1702.5. Shaft Seals

Pump shaft sealing arrangements shall be suitable for the water pressures and shaft speeds involved.

Pumps fitted with soft re-packable or packed gland type, seals shall have stuffing boxes designed to facilitate adjustment of the packing materials.

Pumps shall be fitted with a split type mechanical shaft seal arranged such that replacement of wearing components can be carried out without the need to dismantle the pump.

Special care in the selection of materials shall be taken in order to avoid binding and electrolytic action between the shaft sleeve and he mechanical seal components, particularly where long periods of idleness are inherent in the duty cycle as in the case of standby and storm pumping.

1702.6. Bearings

All pumps shall incorporate bearing arrangements which prevent the escape of lubricant into the liquid being pumped. The bearings shall be located in dust/moist-proof housings.

All bearings shall be liberally rated to ensure cool running and meet the load factors specified.

For vertically mounted pumps, the top bearing shall be as a combined thrust and journal type, designed to prevent any thrust loads being transmitted to the drive motor. The pump bottom bearing shall be lubricated by an enclosed water lubricated sleeve bearing for potable water applications by grease or other approved means for sewage use. Storm pump bearings shall also be suitable for standing idle for periods of up to 2 months without attention or movement.

Where grease points are necessary they shall be fitted with removable screwed plugs which shall be accessible without removing guards. All bearings having automatic lubrication shall also have provision for hand lubrication.

1702.7. Baseplates and Stools

For vertical pump units, heavy cast iron or fabricated steel floor plates and motor stools shall be provided for direct mounting in concrete floors or supporting steelwork. Suitable journal and thrust bearings shall be provided in the baseplates to carry out the vertical drive shaft.

Where necessary the motor stools shall be designed to accommodate flywheels and bearing housings.

Floor plates shall be recessed and so arranged that the tops and fixing bolts are level with the finished floor.

The pump units shall be accurately aligned and located on baseplates by set screws and parallel dowels

1702.8. Lubrication/Cooling Monitoring

A lubrication system shall be arranged for the lubrication of all grease points on the pumps and shafting from motor room level. Individual bearings within the support tunnel tubes and on the pump sets themselves shall receive separate supplies of grease fed by pressure tubes laid from each bearing to battery plates readily accessible from motor floor level for grease gun operation.

Pressure tubes shall be grouped together where possible and securely attached by brackets, straps, etc. to tunnel tubes, with connectors located near to the motor support plate for easy removal of shafting in the event of maintenance work. In exposed positions pressure tubes are protected from damage. Motor grease points will not be included in this lubrication system but shall receive individual attention.

The battery plates shall have sufficient greasing points for all bearings to be located on or adjacent to each pump motor stool.

A notice is to be supplied and fixed on the wall in a prominent position detailing the manufacturer's recommended greasing schedule. The notice shall include a warning of the dangers to bearings from 'over greasing'.

A grease gun shall be supplied for all greasing purposes.

Bearings which require a continuous supply of lubricant shall incorporate a means of monitoring such a supply, either by flow or temperature rise as appropriate for the type of bearing employed; separate monitors being fitted for each bearing feed or housing.

Such monitors shall include all necessary ancillary power of pulse counting devices to enable the operation of any monitor to initiate a volt free contact rated at 240V 0.5 A AC.

1702.9. Pump Tundish

Where specified, each pump shall be equipped with a cast aluminum or fabricated steel tundish to accommodate the drain lines from mechanical seals, casing vent and other minor drainage points on the pump. A single drain pipe shall be run from the tundish to the house drainage system.

1702.10. Air Release Cock

The higher point on the pump casing shall be fitted with a manual air release cock have a removable handle or an automatic air release valve with a lockable isolation valve as specified. Air release pipework on sewage pumps shall be not less than 30mm bore and shall discharge back into the wet well at high level and have facilities for rodding. The drain from each air release cock shall discharge via pipework as specified.

1702.11. Couplings

All couplings shall be of an approved type and the Contractor shall arranged for the provision and fitting of both coupling halves to each respective shaft and shall include for all necessary modifications to any existing shafts to be coupled.

Where specified, the Contractor shall include any equipment required to prevent damage to any part of the drive in the event of reverse rotation of the pumps.

1702.12. Intermediate Shafts

Intermediate shafts between the pump and drive shall include universal couplings at each end allowing free axial movement to avoid end thrust being transmitted. The shaft and coupling shall be fitted with a full length guard manufactured from mild steel mesh on a mild steel framework, easily removable for maintenance purposes.

The frame and mesh shall be hot dip galvanized.

1702.13. Gear Unit

Each unit shall be continuously rated to transmit the full power of the drive either directly in line or through a right angled, helical gear system, having an input/output speed ratio to suit the duty.

The gear case shall be made of substantially ribbed cast iron with machined mounting feet and shall form a totally enclosed, oil tight casing.

The gear unit case and bearings shall be designed to accommodate the total weight of any suspended drive shafting and couplings in addition to any dynamic load imparted during service, and run for a minimum of 10,000 hours before a major overhaul is required.

Where specified, an electric tachometer shall be fitted to indicate the output shaft speed.

1702.14. Lubrication

The gear unit shall be grease or oil lubricated, arranged to provide an adequate supply of lubricant for the duty.

Where oil lubrication is employed, the casing shall include an oil breather, level indicator and drain plug.

Units having a rated output greater than 500kW shall have inspection covers and include a forced lubrication system comprising an oil circulating pump, reservoir tank and full flow 'Duplex' type oil filters having re-useable elements together with associated pipework; the oil being circulated by either (a) an internal mechanically driven gear pump and an external electrically driven pump arranged to prime the gears as pre-set timings as recommended by the unit manufacturer, or (b) duplicate external electrically driven pumps, each of which may be selected to prime pre-set intervals and run when the gear unit runs.

Such a lubrication system shall include dial gauges and alarm switches to monitor high oil temperature and low oil pressure.

1702.15. Reverse Rotation

Where specified, the gear unit shall be capable of withstanding reverse rotation for a limited period with no detriment to the unit. Where a forced lubrication system is used, this shall continue to operate satisfactorily under such conditions.

1702.16. Submersible Sewage Pumps

The pumps shall be fully submersible and of the unchokeable type, capable of passing raw unscreened sewage. They shall have non-over-loading characteristics and incorporate bearings sealed for life.

The sealing arrangements between pump and motor shall be by means of mechanical seals running in an oil bath which serves to lubricate and cool the interfaces of the seals.

The pump shall include renewable and easily replaceable wear rings.

Robustness of construction and the ability to operate automatically with a minimum of attention for long periods is essential.

The pumps shall be supplied with guide rails unless otherwise stated, and particular attention shall be given to the free passage of the pumps up and down the rails without jamming. The pump outlet flange, unless otherwise stated, shall have a boltless coupling on to the flange of the fixed delivery pipework and shall have positive location so as to provide an automatic coupling with a good seal when the pump is lowered into position.

The pump casing shall incorporate a lifting eye of not less than 80mm internal diameter suitable for the attachment of heavily galvanized lifting chains which shall be brought out of the wet well to a conveniently sited fastening.

1702.17. Diaphragm Pumps

The pump shall be of the diaphragm type utilizing a bullfrog type valve, suitable for the pumping viscous solution containing solids up to 55mm diameter as specified. It shall be driven by an electric motor through an oil bath reduction gear unit.

The main body of the pump shall be manufactured from LM6 aluminum and all wetted parts shall be supplied in 316 stainless steel.

The diaphragm shall be manufactured from neoprene, nitrile, hyperlink or viton elastomers and shall be reinforced with polyester fabric.

1702.18. Submersible Borehole Pumps

Pumps impellers shall be closed or semi open type made from zinc free bronze or such other materials required for use with particular water to be pumped. Pump bodies shall be of zinc free bronze or such other material as required for the water to be pumped, treated against corrosion, and equipped with detachable wear rings. The bowls shall be joined by flanges or by tie rods.

The shaft main guide bearings located in the suction and delivery end housings of the pump shall utilize a leaded-bronze material, and shall be provided with protection guards to prevent ingress of sand and grit. Pump bowl guide bearings shall utilize either leaded bronze or other approved abrasion resistant material.

All pump bearings shall be lubricated by the water to be pumped. The pump delivery end housing shall incorporate a thrust washer of suitable material at the shaft end housing to absorb upthrusts that occurs during pump starting. The pump shall incorporate a mushroom type delivery check valve to prevent reverse rotation of the shaft from back flow of water through the pump. The

pumps shall be provided with a flanged discharge connection suitable for operating against the pump closed valve head or 16 bar whichever is greater. The shaft coupling connecting the pump and driving motor shall be of the stainless steel material accurately machined and keyed to ensure a precise shaft engagement and alignment. A strainer of suitable corrosion and abrasion resistant material, designed to guard against entry of foreign matter but permitting unrestricted flow of water into the pump, shall be provided on the pump suction housing.

Protections against the effect of sand shall be provided by renewable wear rings (made from a hard, smooth, flexible material such as polymethane) mounted at the seating of the impellers and the passages of the shaft.

The pump shall be designed to pump water having a sand content of up to $80g/m^3$.

A centralizer shall be fitted to every pump to ensure central alignment of the pumping and motor in the borehole casing.

Electro-submersible motors shall be 'wet' squirrel cage rotor induction type designed to operate continuously under submerged conditions and shall, where appropriate, comply with the requirements of IEC publication 34. They shall have operating speeds not in excess of 3000 rpm.

The motors shall be continuously rated at least 20% above the maximum power absorbed by the pump within the specified operating range. Motors shall be designed to allow three consecutive starts from cold and three starts in any on hour when hot.

The motor housing shall be constructed from close grained cast iron, cast steel or fabricated steel as appropriate, and shall be designed for easy dismantling and re-assembly to facilitate replacement of motor guide and thrust bearings.

The motor windings shall be insulated with an approved heat resistant material of high insulation resistance and impervious to water. All connections on the motor winding shall be made watertight. The temperature rise of motor windings shall be limited to 45ºC above ambient temperature.

The motor shall be equipped, in factory with several PTC or Pt100 thermoprobes, 2 minimum, connected to a multifunction protection relay and a pre-selection digital thermometer which cuts off the operation current of the starter when the threshold temperature is reached. The temperature setting of this device shall depend upon the type of the probe determined by the manufacturer according to the insulation class of the motor. The motor shaft shall be machined from high tensile stainless steel of sufficient diameter to prevent distortion from the dynamic and electro-magnetic stresses imposed on it. Critical shaft speed shall be well above the maximum running speed.

The motor shall be provided with a heavy duty multipad thrust bearing at the base of the motor to absorb the shaft down thrust developed by the pump. The bearing design shall incorporate tilting thrust pads with replaceable segments arranged to self adjust according to the thrust load. The thrust disc shall be of a suitable segment carbon based or similar approved material.

The thrust bearing design shall also be suitable for reverse rotation of the shaft in the event of backflow of water through the pump.

Motor guide bearings shall utilize either leaded bronze, copper impregnated carbon or similar approved material. Rubber, nylon, Tufnell and similar materials will not be accepted for the motor guide bearings.

Motor guide and thrust bearings shall be lubricated by the motor coolant water which shall be effectively isolated from the water to be pumped. A compensating device shall be incorporated in the motor design to allow for expansion of the coolant on rising temperature.

1702.19. Borehole Pumps Rising Column

Steel borehole rising column shall be provided in section lengths not exceeding 3 metres with flanged joints or screwed couplings. The rising column shall be sufficiently flexible to allow for small deviations in borehole verticality. All nuts, bolts and washers shall be of stainless steel.

Rising column flanges shall incorporate a recess to accommodate and protect the motor power and control cables, water level dip tubing, etc. Cables and tubing shall be securely fixed to the rising column by straps or bands at approximately 2 metre intervals.

The rising column shall be sufficient to take the stresses generated by the hanging weight of the pump, motor and rising column, the stresses produced by the water pressure together with any dynamic stresses which may occur under any circumstances including valve closure. Jointing materials shall be selected with care and shall accommodate the extension of bolts due to the expected weight and surge or closed valve pressures generated in the pipeline.

The rising column shall be protected internally and externally against corrosion by a non toxic epoxy resin coating suitable for use with potable water.

1702.20. Borehole Pumps Headworks

A fabricated steel discharge head piece shall be provided at the top of the borehole to support the complete rising column and electro-submersible pumpset assembly, and shall be complete with lifting eye bolts. The discharge head piece shall comprise a heavy duty sealing plate arranged for bolting to the borehole outer casing flange, and a 90º discharge bend arranged for flanged connection to both rising column and horizontal surface pipework. Lifting eyes shall be provided in the sealing plate. A flange shall be provided and welded by the Contractor to the top of the borehole outer casing. The flange shall be suitably drilled to accommodate the discharge head piece sealing plate bolts. Holes shall be provided in the sealing plate to accommodate an air vent pipe, motor and control cables, water level dip tubing, etc. and shall include adequate sealing arrangements to protect against borehole contamination. A 255mm diameter screwed removable plug shall be provided over the dip tubing for water level measurement with electrical contact tape. A stainless steel air vent pipe shall be fitted to the discharge head sealing plate, terminating in an insect proof screen and arranged to prevent entry of rain or surface water.

Borehole power and signal cabling shall be brought to separate robust watertight junction boxes in the top of the well head chamber, with separate cabling from the junction boxes to the Motor Control Centre (MCC).

1702.21. Vertical Turbine Pumpsets

The pumps shall be of the vertical line shaft type. The discharge head shall be bolted onto a substantial steel bedplate or frame which shall in turn be bolted to the pump room floor. The discharge head shall have a flanged discharge. The suction casing and impeller bowls shall be of

cast iron. Replaceable seal rings shall be fitted on to the impeller suction side if required to maintain pump hydraulic efficiency.

The impeller shall be bronze or other material to suit the characteristics of the water to be pumped. The pump shaft shall be of stainless steel supported by bearings above and below each stage. Protection shall be given against the effects of entrained solids in the water being pumped intermediate bearings shall be lubricated by the liquid being pumped.

The line shaft shall be machined and ground carbon steel supplied in lengths not exceeding 3.0m, with screwed couplings. The line shaft bearings shall be spider type to locate the shaft in the tube and may also double up as line shaft tube couplers. Lubrication shall be provided to the bearings.

The pump suction shall be of at least equal diameter to the pump and shall be fitted with a suction strainer.

Means shall be provided of adjusting the pump shaft tension and position.

1702.22. Chemical Metering and Dosing Pumps

Chemical dosing shall be by means of electrically driven metering pumps unless otherwise particularly specified.

Metering pumps shall be of the plunger or progressive cavity type.

The effective range of the metering pumps shall be between zero and maximum with an overall repeatable accuracy within ±3%. Output shall be adjustable through a stepless variable stroke mechanism in the case of plunger pumps and variable speed motor or gearbox in the case of progressive cavity pumps.

The metering pumps shall be manually adjusted, and shall be calibrated to allow setting at the required dosage. Dose adjustment shall be possible whist the units are in operation. Accurate dosing shall be maintained down to 10% of the maximum dosing rate.

The Contractor shall consider the liquid to be pumped and select the materials of construction so as to avoid corrosion. Mechanical glands are generally undesirable but where unavoidable, shall be to the approval of the Engineer.

For metering pumps of the plunger type the materials in contact with the liquid shall be polypropylene, stainless steel grade 316, uPVC or PTFE. Plungers shall be a high-alumina ceramic or stainless steel, grade 316.
Metering pumps shall be mounted on bed plates which shall be protected from gland dip. The pumps shall be driven by close coupled motors with reduction gears and have mechanisms housed in a totally enclosed oil bath.

At least one standby pump, fully connected into the chemical dosing system, shall be provided for each chemical, with local manual selection of duty and standby units. When pump duty changeover is effected, the appropriate suction and delivery isolating valves shall be manually operated.

Stators and rotors for progressive cavity pumps shall be of materials selected having regard to the liquids being pumped.

The design and location of the metering pumps shall be such as to facilitate easy dismantling for the removal of any foreign matter.

Flushing facilities shall be provided for all chemical pipework at the inlet and outlet of each metering pump, together with drip trays to contain any spillage or leakage and piped to the nearest drain point. Provision shall be made for priming the system to eliminate any air.

Each chemical dosing pump shall be provided with suitable isolating valves, an inter-connecting manifold system and, where necessary, loading valves. A calibrated glass container shall be provided connected into the suction manifold of each chemical pump so that its output can be checked.

Calibration curves shall be provided by the Contractor for all chemical dosing pumps.

1702.23. Surge Suppression Equipment

Surge vessels and associated equipment for suppression of surge in pumping systems shall include the following:

Surge pressure vessel designed and constructed to BS 5500, constructed category 1, 2 or 3, post weld heat treated and with a corrosion allowance of 1mm. The vessel shall be cylindrical, carbon steel, fusion welded with domed ends and mounted either vertically or horizontally on steel supports. The vessel shall be provided complete with including the following fittings:

- McNeil type access manhole with opening not less than 450 mm x 410 mm;
- Water inlet/outlet branch flanged to BS 4504 Table 16 or 25 as necessary;
- 100 mm diameter drain branch with gunmetal valve and handwheel with drain pipework discharging to drainage channel;
- Spring loaded gunmetal safety valve;
- 150 mm diameter pressure gauge complete with isolating cock;
- Water level sight glass with isolating and blowout prevention valves;
- Air inlet fitting incorporating an air release valve and isolating and non-return valves;
- Three stainless steel water level control electrodes of appropriate length, complete with electrode holders, spacers and brackets;
- Access ladder;
- Lifting lugs;
- Nameplate giving vessel details.
- One or more air compressors with standby facilities. Each compressor shall be capable of charging the pressure vessel from full water in approximately 30 minutes. The compressors shall be air cooled, electrically driven and complete with baseplates.

The compressors are required to deliver completely oil-free air but may be of the air lubricated type with two stage carbon air delivery filters providing complete removal moisture and oil vapour. Each compressor shall be provided with the following fittings:

- Outlet pressure gauge;
- Pressure relief valve;
- Suction filter and silencer;
- Automatic unloading valve for a no-load start under all conditions;

- Non-return valve;
- Protective guard between motor and compressor.

Control equipment to provide fully automatic control of the selected duty compressor from the water level electrodes in the surge vessel. A time delay shall be incorporated to prevent operation of the compressor during water level changes under surge conditions and a push button feature shall be provided for manual test of the system. The control equipment shall be housed in a wall mounted panel fabricated from mild steel to form a rigid box construction of neat appearance providing an enclosure to IP54. The enclosure door shall be hinged with a rotating handle and positive closing action. The equipment shall include:

- A three pole isolating switch, with operating handle interlocked with the enclosure door;
- A water level control module;
- A 0 to 30 minutes adjustable timer;
- A non-latching motor test push-button.

Ductile iron flanged inlet/outlet pipework between a flanged tee on the pumping station or wellhead delivery pipework and the surge vessel. The pipeworks shall include an isolating valve with gearing and handwheel and all necessary bends and fittings.

Small diameter GMS pipework between the air compressors and the surge vessel. The pipework shall be suitably coated and wrapped.

For small installations a vessel with a flexible membrane and hand air pump may be used.

1703. VALVES AND PENSTOCKS

1703.1. Types and Operating Conditions

Valves shall be designed to meet the operational and environmental conditions specified for the types indicated in the specific valve schedule.

The closure rates of all valves shall be designed to prevent the effects of surge. Where necessary, valves with a varying closure rate shall be used.

Valve flanges or couplings shall be as specified in the valve schedule and match those specified for the pipework installation.

1703.2. Identification

Each valve shall be identified by a unique reference as approved which shall identify the medium/plant controlled and be numbered in a logical sequence.

The reference shall either be engraved on a 3mm thick laminated white/black/white traffolyte disc or stamped on a1.0mm (19g) thick brass disc. The disc shall be at least 35mm diameter with reference letters and numerals not less than 4mm and 8mm high respectively.

The discs shall be mounted on the hub of the handwheel or where this is impractical, they shall be attached to the valve stem by means of suitable brass ‘S’ hooks and/or jack chain through a hole at the top of the disc.

1703.3. Access

All valves, spindles and handwheels shall be position to give good access for operational personnel. It shall be possible either to remove and replace or to recondition seats, gates or gland packings which shall be accessible without removal of the valve from the pipework or, in the case of power operated valves, without removal of the actuator from the valve.

Extension spindles shall be supplied wherever necessary to achieve the specified operating requirements.

1703.4. Hand Operation

All handwheel shall be arranged to turn in a clockwise direction to close the valve or penstock, the direction of rotation for opening and closing being indicated on the handwheels.

The handwheels shall be coated with black plastic and incorporate facilities for padlocking in either the open or closed position.

The operating gear of all valves and penstocks shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified service value and any gearing shall be such as to permit manual operation on a reasonable time and not exceed a required rim pull of 200kg.

Power operated valves shall include equipment for manual operation by means of a handwheel or other suitable device which shall be interlocked with, and fixed to, the power unit.

Headstocks and valves of 50mm nominal bore and above shall be fitted with mechanical position indicators to show the amount which the valve is open or closed in relation to its full travel, i.e. 0.25, 0.50, 0.75, 1 etc.

1703.5. Valve Materials

Valve bodies and other components shall be of corrosion resistant materials, compatible with the medium and of robust industrial design.

For water applications and where specified, valve bodies, discs and wedges shall be of cast iron, with facing rings, wedge nut and other trim of carrions resistant bronze or gun metal.

The valve stem, thrust washers, screws, nuts and other components exposed to the water shall be of a corrosion resistant grade of bronze or stainless steel.

For water works applications, wedge gate, metal seated valve materials shall be in accordance with BS 5163 Table 6A, fitted with a stuffing box and gland seal on the stem. Oil or grease shall not be used on any bearing or seal that may be in contact with the water being controlled.

1703.6. Gate Valves

Gate valves shall comply with the requirements of BS 5163, BS EN 1074, AWWA C203-78, DIN 3230 Part 1-3, DIN 3352 Part 1-4, or other equivalent standards.

Unless otherwise specified gate valves of nominal diameters up to and including DN 300 shall be resilient seated. With the body, the bonnet and the gate of the valve made of epoxy coated cast ductile iron in accordance BS EN 1563 or BS EN 1564. The epoxy coating shall be not less than 150 microns thickness. The gate shall be ductile iron and completely rubber encapsulated with elastomer EPDM, nitrile or equivalent, the gate valve being of pocketless type with a straight through port.

The gate sealing shall be ensured by compressing of the rubber. Wedge/gate guides of wear resistant plastic with high gliding features shall be provided in the body, optimally placed to guarantee low wear and tear of the gate and low closing torques.

Gate valves of nominal diameter larger than DN300 shall be of metal seated design with replaceable bronze facing seal/seat rings.

Gate valves shall be capable of sustaining a maximum permissible differential working pressure as indicated on drawings or in Schedule of Prices and Unit Rates. Gate valves shall be provided with integral flanged ends unless otherwise indicated.

Unless otherwise specified the face to face dimensions of gate valves with integral flanged ends shall be in accordance with EN 558 and EN 12627 basic series 14 (short) or basic series 15 (long). Gate valves shall be of the non-rising stem type except where specifically indicated otherwise. The stem seal shall be of toroidal sealing rings (O-rings) with at least two such seals. Seals shall be capable of being replaced with the valve under pressure and in the fully open position.

The gate valves shall be double flanged. The dimensions and drilling of flanges shall be in accordance with BS EN 1092. Flanges shall be machined flat. Flanges shall be NP 16 / NP 25 complying with BS EN 1092, unless otherwise indicated Price Schedules.

The bonnet gasket shall be of elastomer (suitable for potable water). The bonnet studs or Allen screws shall be corrosion-protected. In addition the studs/allen screws shall be placed in countersunk holes in the bonnet and completely sealed with wax or a suitable material, which could be removed by low-temperature melting in case they have to be disassembled.

The operating stem shall be made of stainless steel at least equivalent to ISO 10088 Part 1.4021, except in areas of aggressive soils where this shall be to ISO 10088 Part 1.44404.

The stem nut shall normally be made of high tensile brass to BS 1981, except in areas of aggressive soils where this shall be aluminium bronze to EN 12167.

Spindles of the gate valves shall be provided with cast iron caps conforming to the requirements as specified under “Valve Caps” in DIN 3230, DIN 3352, BS 5163 or AWWA C203-78, or handwheels if so specified.

Furthermore and in aggressive soils, outside bolts and nuts shall be made of stainless steel to ISO 10088 Part 1.4301 or as detailed on drawings.

Stuffing boxes shall be designed to have soft packing fitted and arranged so that it can be re- packed under pressure.

All valves shall be suitable for operation from the closed position by a 13 kg "push-pull" effort (total 26 kg) at the rim of the hand-wheel or tee key. Gearing and by-pass arrangement shall be provided for Gate Valves > 400mm dia.

Valves shall be tested to 1.5 times the normal working pressure. The gate valves shall be subject to "Closed End Tests" in accordance with the procedure set out in BS 5163, AWWA C203-78, DIN 3230 Part 1-3, DIN 3352 Part 1-4.

1703.7. Telescopic Valves

All bellmouth telescopic valves shall have cast iron outer sleeves and bellmouths. The outer sleeves shall have machined labyrinth seals and the sliding tubes shall be manufactured from zinc free bronze.

A cast iron stirrup shall be affixed over the top of each bellmouth and these shall be connected to the rising screw thread by means of a stainless steel 'Rose' type coupling. To minimize fouling by rags etc. the valves shall not be fitted with outer guide rods.

1703.8. Non-Return Valves

Non-return valves shall be suitable for waterworks purposes and shall be manufactured to comply with the general requirements of BS EN 12334. They shall be double flanged type, non-slamming and recoilless on flow reversal. Valves of DN 700 and larger shall be of the multi-disc type or tilting disc type. The valves shall have a high grade cast iron body and cover to BS EN 1561 Grade 220/260 with gun metal nickel bronze alloy door seating. The hinge pin shall be of stainless steel carried on non-corrodible bearings.

All non-return valves shall be of a type that will operate without stock.

Valve shall be fitted with renewable type seatings.

In the case of swing gate type valves the hinge pin shall be of stainless steel, mounted in zinc free bronze bushes and extended and fitted with external levers and counter balance weights, all protected by a screen guard.

Other types of valves will be considered. In every case the non-return valve shall be selected with full consideration of the system characteristics, and shall avoid valve slam, and have low maintenance requirements.

Where specified, limit switches shall be provided to operate from the external lever. The screen guard being slotted to allow the guard to be removed without disturbing the switch cabling.

1703.9. Butterfly Valves

Butterfly valves shall conform to BS EN 593 and shall be double flanged, resilient and metal seated tight shut-off design and of the eccentric disc type supported from two shafts placed in self-lubricating bearing bushes. Gearing and by-pass arrangement shall be provided for Butterfly Valves > 400mm dia.

Butterfly valves shall be capable of sustaining a maximum permissible differential working pressure as indicated on drawings or in Schedule of Prices and Unit Rates.

Butterfly valves shall operate with a clockwise closing direction. The valve disc shall rotate though an angle between 0^0 and 90^0 inclusive. Butterfly valves shall be installed with shaft in horizontal position and the bottom half of the disc opening in the direction of flow.

The sealing ring shall be made of EPDM rubber and shall be attached at the disc edge circumference by a retaining ring without adjustment to form a resilient and durable seal. The valve disc seal shall be replaceable without dismantling the operating mechanism, disk or shafts, and without removing the valve from the pipeline.

Alternatively, the valves can be fully EPDM lined, with stainless steel discs to AISI 304.

Butterfly valves shall be equipped with an irreversible and proportional worm gear operator. This shall be either with or without an additional primary reduction gear placed within a waterproof housing depending upon nominal valve diameter and maximum working conditions. The time of closure from valve fully open to valve fully closed shall not be Less Than FOUR MINUTES for valves in the Raw Water Pipeline and TEN MINUTES for valves in the Treated Water Pipeline.

The operating mechanism shall be permanently lubricated, not in contact with the water, and provided with an OPENED/CLOSED proportional position indicator in order to indicate the disk angular position. The mechanism shall be sized in order to minimise torque for ease of manual operation under maximum differential pressure and shall be with high class enclosure IP67 to ISO 60529. They shall be self-locking and designed to hold the valve in any intermediate position between fully open and fully closed without creep.

Valve body, disk and disk retaining ring shall be in ductile "SG" iron casting to EN 1563, EN 1564 or EN-GJS-400-15. Disk shafts shall be in stainless steel to EN 10088:1.4021 or AISI 304, complete with non- corrodible bearings.

Butterfly valves shall be works pressure tested in accordance with BS 6755 and EN 12266 Parts 1 and 2.

i) Body test at a minimum pressure of 1.5 times the maximum permissible pressure
ii) Seal test at a minimum pressure of 1.1 times the maximum permissible pressure.

Butterfly valves shall be suitable for flange connections. Wafer type valves may be used where appropriate to suit the existing pipework arrangement.

Valves shall allow flow in either direction and shall be satisfactory for duties including isolation of pipeline section, frequent operation, and for applications involving valve operation after long periods of inactivity.

Butterfly valves shall have resilient disc seating and shall be drop tight.

The Contractor shall ensure that there is sufficient clearance between the disc and the adjoining pipework to ensure that all Butterfly valves operate freely, from fully open to fully closed and vice versa, under all conditions.

1703.10. Plug Valves

Plug valves shall be of the wedge gate type, with cast bodies. The plug surface shall be coated or lubricated to endure low torque operation with bubble tight shut-off and 'non- sticking' materials.

1703.11. Stop Valves

All stop valves shall be in accordance with SRN 826. Samples of valves shall be submitted for test and approval to the Engineer.

1703.12. Isolating Cocks

For isolation of small bore pipework tappings for instrumentation equipment etc. and for individual component isolation, the cocks shall be stainless steel, quarter-turn, ball or plug valves with the operating handle arranged to indicate the open and closed positions. Where specified, means shall be provided for securing the valve body to a front panel or rear surface.

Where corporation cocks are specified, these shall be similar to the above isolating cocks but shall have a detachable key handle for fitting onto a squared operating shaft, the shaft end being marked to indicate the open and closed valve positions.

1703.13. Extension Spindles

Extension spindles shall be adequately sized to prevent buckling and shall be attached to the valve/penstock stem by a suitable adaptor incorporating two muff couplings, scarf lap jointed and pinned with at least two coupling joints included. Universal joints and waterproof sleeves shall be provided where specified. Extension spindles shall be manufactured from 080M40 (EN 8) steel.

Intermediate bearing support or guide brackets of cast iron, with slotted holes for site adjustment, shall be fitted to long shafts where necessary. Bearings shall be of PTFE or similar approved type.

1703.14. Pedestal and Spindle Covers

Penstock and valve pedestals shall be of cast iron or heavy duty, welded, mild steel construction with a substantial base and fixing provision. The base and top of the pedestals shall be machined normal to the axis of the drive shaft.

Where necessary, support guide bushes shall be fitted as the base of the pedestal.

The pedestal height shall be such that the handwheel is approximately 1 metre above the operator's floor level.

Covers of an approved type shall be provided for all rising spindles to totally enclose them when in the fully raised position.

1703.15. Penstocks

Cast iron penstocks shall be all in accordance with SRN 906 and SRN 916. Seating faces shall be

gun metal or bronze.

All penstocks shall be designed and installed so that the maximum working pressure acts in a seating direction on the gate.

Both gate and frames shall be sufficiently rigid to withstand twice the maximum working pressure and any eccentric pressures created by the tightening of the anchor bolts during installation. All penstock frames shall have a spigot back.

The frame shall be of the rising spindle type unless otherwise specified, and the spindles shall be of adequate size to avoid buckling under load.

All spindle nuts shall be self aligning and their length shall be not less than twice the spindle diameter.

Spindles shall be threaded as necessary and non-rising unless otherwise specified. Spindles shall be of aluminium bronze, manganese bronze and extension spindles may be of mild steel.

Handwheels shall be of cast iron and words “OPEN” and “SHUT” marked on upper side with appropriate direction arrows.

The top part of the penstock frames shall be sufficiently robust and substantial to prevent the frames bowing and if necessary, additional holding down bolts shall be fitted. The penstocks shall be fitted with matching wedges on doors and guides, the wedges shall be fitted with renewable seatings of zinc free bronze. Under no circumstances shall wedges be fitted to the bottom or lower section of the penstock doors. The wedges shall be adjustable with stainless steel adjusting screws and shall be readily removable.

On rectangular penstocks the inverts shall be flush with renewable synthetic rubber seals on the bottom of the doors. The rubber shall be suitable for the application and of an approved type.

The doors shall have lifting eyes cast in, or eye bolts of sufficient size to permit the lifting of the door against seating pressure.

1703.16. Penstock Materials

Penstock doors, wedge support beams, frames, guides, frame extensions, headstocks and bridge pieces shall be cast iron, of minimum grade 220 to BS 1452. Doors and frames shall be fitted with renewable seatings of zinc free bronze.

Spindles shall be manufactured from stainless steel 431s29 (EN 57) or similar approved material.

1703.17. Templates

Simple templates shall be supplied as soon as possible after approval of drawings to enable the civil works engineer to position the holes for holding down bolts for all penstocks over 1.0 m square.

1703.18. Air Valves

Air valves shall be either:

- Single (small) orifice valves (SAV), for the discharge of air during the normal operation of the pipeline.

- Double orifice valves (DAV), consisting of a large orifice and a small orifice. These shall permit the bulk discharge of air from the main during filling and air inflow when emptying in addition to the discharge of small quantities of air during normal operating conditions.

The double orifice type of air valve shall comprise a small and large orifice unit with common connection to the main and screw-down isolating valve to permit inspection of the valve. The spindle of the isolating valve shall be screwed so as to close the valve when rotated in a clockwise direction and be provided with a Spindle Cap to dimensions as specified in DIN 3230, DIN 3352, BS 5163 or AWWA C203-78.

Air valves shall be supplied with an independent isolating butterfly valve (DAV) or cock (SAV) which permits the complete removal of the air valve from the main, without affecting the flow of water in the main.

Each air valve assembly shall be suitable for connection to a flange on the pipeline.

At the connection between the air valve and its isolating valve a BSP tapping shall be made suitable for fitting of a pressure gauge. All tappings shall be sealed by a brass plug and copper compression ring gasket.

Air valves shall operate automatically and be constructed so that the operating mechanism will not jam in either the open or closed positions. Design of the air valves shall be such that the balls do not blow shut under any working or test conditions when large volumes of air are being released.

1703.19. Dismantling Joint

Suitable dismantling joints shall be installed in all pipework allowing the dismantling of all valves and instruments.

- Material:
  a. Spheroidal graphite cast iron, stainless steel
  b. Material for Gaskets: EPDM
- Epoxy coating inside and outside
- Min. Adjustability: +/- 20 mm
- Pressure classes: PN 10, PN 16, PN 25 and PN 40 as indicated.
- Flange connection according to pressure class and as specified

Nominal diameter		[mm]	50	80	100	150	200	250	300	350
Nominal length for	PN 10	[mm]	180	200	200	200	220	220	220	230
	PN 16	[mm]	180	200	200	200	220	230	250	260
	PN 25	[mm]	200	210	220	230	230	250	250	270
	PN 40	[mm]	200	210	220	230	240	260	280	290

1704. PIPEWORK

1704.1. General

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

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

b) All items hereinafter specified shall be to the required Standard and the Standard or Specification must be submitted to the Consultant for approval before commencement of work. Other Standards or Specification will only be accepted if they are equal or higher and if, in the opinion of the Engineer, they provide for a satisfactory quality of material and workmanship.

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

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

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

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

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

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

i) Where necessary the Supplier shall provide rubber gaskets to comply with EN 1514, DIN 2693 or DIN 2697 and all other bolts, nuts, washers, etc. to undertake jointing at fittings etc.

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

k) Wherever possible, samples of pipes and fittings shall be submitted for approval of the Consultant prior to the Supplier obtaining the total requirements.

1704.2. Systems Design

All pipe systems shall be arranged, installed, supported and provided with all necessary means of venting, draining and expansion subject to the approval to the Engineer before erection commences.

The pipework layout shall be designed so that items of equipment and sections of pipework can be removed from the pipelines without major disturbance to the adjacent pipework. Particular care shall be taken to ensure that pipework thrusts are not transmitted to machinery or associated apparatus. The Contractor shall indicate on his detailed drawings the thrust blocks required to anchor his pipework.

Dead legs shall be avoided, but where this is not possible provision shall be made for flushing the pipework. Changes in pipe bore sizes shall be by the use of proprietary fittings or fabricated sections to avoid sudden changes.

Where relevant, formed bends and offsets shall be used and be cold formed in a standard pipe bending machine. They shall have an inside radius of not less than 4 times the outside diameter of the pipe.

Hydraulic pipework. Pipework for pressurized hydraulic fluid shall be sized to maintain fluid velocities below those which specified and provide a safety factor of 4:1 on the design pressure, which shall be taken as 120% working pressure;

Compressed air pipework. Air pipework shall be sized such that the air flow velocity does not exceed 8m/sec. To provide adequate condensate drainage, the pipework system shall be run with a horizontal fall of not less than 1 in 50 in the direction of air flow and incorporate drainage points at distances of not less than 30m. Drainage points shall be formed by the use of equal tees with a down-pointing leg fitted preferably where changes of direction of flow occur.

Any branch take-off shall be from the top of the main and the bottom of any falling pipe shall be drained.

1704.3. Flanges

Unless otherwise specified flanges shall be faced and drilled to conform to the dimensions specified in BS 4504. Flanges shall be compatible with the pressure rating of the adjacent pipework but not less than 14 bar. Bolts, nuts and washers (two washers per bolt) shall be to BS BS EN 1092-3;2003. No bolt shall project more than two full threads beyond its nut after tightening. In no circumstances shall the shortening of excessively long bolts by cutting be allowed.

Gaskets shall comply with replaced by BS EN 1514 (1997) and replaced by BS EN 681-2 (2000) and BS 681-1 (1996) Type W.

Flanges shall be painted with two coats of epoxy resin paint.

1704.4. Mechanical Couplings

Unless otherwise specified or shown in the Drawings pipes and fittings shall be supplied with flexible joints.

Mechanical couplings shall be of the Dresser, Viking Johnson type without a centre register. Joints rings used shall be of the ethylene propylene rubber (EPDM) or other material approved by the Engineer.

All mechanical couplings and flange adapters including nuts, bolts and washers shall be supplied with 'Rilsan' nylon thermoplastic polyamide applied by fluidized bed dipping.

1704.5. Materials for the Assembly of Flexible Joints

Lubricant shall be of a kind not conducive to the growth of bacteria and shall have no deleterious effects on either the joint rings or pipes. Lubricants for water supply shall not impart to water, taste, colour, or any effect known to be injurious to health.

1704.6. Materials

Pipework materials, sizes, pressure rating, fittings, coupling arrangements and median carried shall be as detailed in the Particular Specification, BoQ or drawings, pipework being in standard metric sizes where possible.

General purpose steel pipework with screwed fitting shall be of galvanized mild steel to BS 1387 heavy grade with fittings of galvanized malleable iron to BS 143/1256, having tapered internal and external threads to BS 21.

Flange joints shall be as specified below for the application and all necessary bolts, nuts and washers shall be cadium plated. Welded joints in carbon steel pipe shall be to Class II quality to BS 2640 or BS 2971. Welding shall only be carried out by welders who are approved in accordance with the relevant BS.

Water pressurized system shall use pipe-work of carbon steel in accordance with BS 3601 with pipe sizes to BS 3600. Sizes greater than 80mm shall be selected from the preferred sizes 100, 150, 200, 300, 450, 600 and 800mm.

Flange sizes shall to BS 4505 rated NP16 unless otherwise specified.

All flanged joints shall be made with 3mm thick rubber canvas reinforced insertion rings complying with BS 4865 Part 1 table 16A.

Low pressure large bore systems shall use steel pipes and fittings to BS 4622 unless ductile iron pipes and fittings to BS 4772 are specified. Screwed or cast flanges shall have a minimum NP16 rating and be fitted with 3mm thick rubber canvas-reinforced insertion rings.

Hydraulic pipework shall be of stainless steel high pressure tubing grade CFS 316 to BS 3605 or mild steel grade CDS 23/S to BS 3602 as specified.

Flexible hoses shall be of the twin wire braid reinforced type complying with BS 3832.

Pipe fittings not normally visible or accessible after installation shall be of the welded socket type with break joints at suitable positions for maintenance.

All other fittings shall be of the compression type in mild steel with an electroplated corrosion resistant finish.

Air pipework. - As for general purpose pipework except where otherwise specified. Low pressure air pipework shall be cast iron to BS 2035 Class C, flanged to BS 10 Table E. Internal surfaces to be cleaned and treated suitable for passing clean, humid air.

Gas pipework. As for general purpose pipework unless otherwise specified.

Fuel oil pipework. As for general purpose pipework except that pipework fittings shall not be galvanized.

Exhaust pipework. As for general pipework except that pipework and fittings shall not be galvanised. Flanges shall be to BS 10 Table D.

1704.7. Joint and Pipe Fastenings

All nuts, bolts, washers, flanges, gaskets, flanged tied adaptors, drain valves, special connection pieces, supporting hangers, brackets or clips and temporary supports for the pipework, together with all terminal point connection material shall be supplied and installed under this Contract.

All flanged joints shall be fitted with suitable insertion ring gaskets which shall be carefully adjusted concentric to the bore of the pipe so that no undue strain is placed on any of the bolts or flanges of the pipe when bolting up.

Joints on flanges that exist or have been installed under other contracts shall be made with the same material and suitable for the flange faces.

Flushing and drain connections on pipework below 150mm shall be made using proprietary welded fittings with G series internal parallel threads to BS 2779 which shall be immediately sealed with steel hexagon headed shouldered plugs and seals. Holes thus made in the pipe shall have any burrs removed and be finally pulled through to remove loose particles.

Flanged Joints
Where specifically called for or deemed appropriate, flanged joints shall be utilised. They shall conform to DIN Standards 2500, 2501, 2519, 2576, 2627, 2566, 2655-56, 2673, 2526, 2527, BS EN 1092, BS 1560 or ISO 7005: 1988., drilled to NP10 except where otherwise indicated in Price Schedules, with gaskets made of reinforced elastomer rubber to DIN Standards 2693, 2697 or EN 1514 and minimum thickness of 3mm.

Inspection gaskets for flanged joints shall be rubber reinforced with cotton, 3mm thick and shall be in accordance with DIN Standards 2693, 2697 or EN 1514. Bolts, washers and nuts for flanged joints shall be of mild steel complying with ISO 898/1, ISO 898/2.

Flexible Joints
All flexible couplings (Viking Johnson or other approved type) shall be supplied and shall be coated with fusion bonded epoxy layer 350 microns thick, complete with rubber gaskets, bolts, nuts and

washers. All couplings shall be coated with red oxide primer and bituminous composition suitable for use with potable water.

Flexible couplings shall be of a mechanical type coupling consisting of a centre sleeve, two end ring flanges, two wedge shaped sealing rings of grade T Nitrile rubber, and with galvanized nuts bolts. The main components shall be made from malleable cast iron to ASTM A 47-77 for larger diameters. If specifically called for, couplings shall be provided with a suitably sized screw plugged hole in the sleeve to allow for the introduction of molten bitumen for additional internal protection. The manufacturer shall then include the necessary removable internal backing-up rings of rubber composition and shall further include for all materials for in-situ jointing and protecting both for remedial works and for internal and external protection at such joints. After jointing, the exposed part of the bolt shall be provided with a tight-fitting polythene protection cap.

1704.8. Template Pipes

Template or closure pipes shall be provided where necessary to facilitate erection. The design and construction of the template pipes shall be to the approval of the Engineer, and the Contractor will be responsible for establishing the dimensions of the template pipes such that there will be no strain on the connected items after installation.

1704.9. By-passes

Where pipeline flow meters are used, particularly electromagnetic meters, by-pass pipework and valves shall be installed to allow removal of the meter without interrupting the process flow. Draining shall either be via backflow or drain valves.

1704.10. Flanged Adaptors

Flanged adaptors shall be provided as indicated in the Specification drawings. Each adaptors shall be complete with all associated fittings and shall be installed in accordance with the manufacturer's instructions.

1704.11. Branch Pipe and Bosses

Whenever any small bore pipework makes a connection into the pipeline system, a boss of branch pipe shall be provided which shall be at least twice the diameter in width and one diameter in thickness of the tapped hole which it contains.

Bosses shall be located at the main pipe horizontal centre line and those provided for water sample cocks shall be tapped 38mm (1.5") BSP and have reasonable access for sampling. Bosses provided for instrumentation equipment shall be tapped 1" BSP with a reducer fitted to suit the small bore pipework and isolating cock. Unused bosses shall be fitted with blank plugs having a central squared projection for tightening or removal.

1704.12. Small Bore Pipework

Small bore pipework up to 15mm OD shall be manufactured from stainless steel tubing with suitable compression type fittings. All smart bore pipework and capillary tubes shall be adequately and securely clipped or clamped. Compression fittings bends shall be kept to a minimum, as

pipeline bends of generous radii are preferred. Compression couplings shall be heavy series to BS 4386 Part 1.

Any gauges, transducers or switches etc. fed via small bore pipework shall have an individual isolating cock adjacent to each component with adequate space being allowed for component removal for servicing.

1704.13. Duct Seals

After the pipework is installed, the Contractor shall seal the ends of all ducts, pipes or trenches leading into buildings, whether occupied or not, for pipework associated with this Contract.

The seals shall be approved water, gas and fire sealing transit units with appropriate fillers, and insert blocks shall be fitted to duct trench entries. All steelwork on such transit assemblies and frames shall be hot dip galvanised. Where shown on the Engineer's drawings, transit frames will be incorporated in the construction by the Civil Works Contractor.

1704.14. Reference Marking

Prior to dispatch from the manufacturer's works each pipe section shall be marked with an appropriate reference number for future identification.

1704.15. Protection of Pipework

Immediately after the completion of fabrication at the works or on site and during transport and storage, pipe ends shall be protected from external damage and sealed against ingress of dirt by suitable caps, plugs or other similar means. After cleaning and inspection, machined surfaces of all steel and ironwork shall be covered with preserving fluids of approved type otherwise protected and all flanges shall be fitted with blank discs bolted to each face.

1704.16. Unplasticised PVC (uPVC) Pipes

Unplasticised PVC piping shall be in accordance with BS EN 1452.

The maximum sustained working pressures to which the pipes and fittings will be subjected is based on water at a temperature of 20 degrees centigrade.

The Supplier shall submit full details of the pipes he intends to supply.

The pipes up to and including 40mm diameter can be of a solvent weld type. The pipe shall be supplied with interchangeable sockets preformed at the factory and of such internal diameter that it takes the plain end of the pipe with the same nominal diameter.

The joint shall sustain the end thrust to which the pipe shall be subjected. The Supplier shall supply sufficient quantity of the cleaner and adhesive which shall be required to make the joints with the pipes.

The pipes of 50mm diameter and over shall consist of a grooved socket at one end of the pipe. The socket shall be designed to give a clearance fit on the outside diameter of the parent pipe. The sealing medium which shall seat in the groove shall be a rubber ring.

If the formation of the socket and groove results in the thinning of the original wall thickness of the pipe, it shall be compensated for by shrinking on to the outside of the socket area a reinforcing sleeve of the same material as the pipe. The socket and groove shall incorporate no sharp angles where the stress points are created.

The joint shall take 10% deformation of the spigot at the point where it enters the socket without leakage from the pipe when subjected to the test pressure specified for the pipe. Thermal expansion of the pipe shall be accommodated in the joint. The joint shall be capable of linear deflection up to 3 degrees.

The sealing ring shall be of first grade natural rubber and the physical properties of the mix shall meet the requirements of DIN 4060, BS2494 or EN 681.

The Supplier shall supply sufficient quantity of any lubricant or other material which shall be needed to make the joint which shall be assembled by hand.

The Supplier shall submit full details of the type of joint offered and a full description of the method of jointing.

The fittings shall have the same type of joint as for the pipes to be used. The Supplier shall submit full details of the materials dimensions and test pressures of the fittings offered.

Precautions shall be taken to avoid damage to the pipes and fittings. In handling and storing the pipes and fittings, every care shall be taken to avoid distortion, flattening, scoring or other damage. The pipes and fittings shall not be allowed to drop or strike objects. Pipe lifting and lowering shall be carried out by approved equipment only. Special care shall be taken in transit, handling and storage to avoid any damage to the ends.

Pipes and fittings shall be marked at not greater than one metre intervals showing their class and diameter.

1704.17. High Density Polyethylene (HDPE) Pipes

HDPE Pressure Pipes and Fittings shall be manufactured using a pre-compounded blue pigmented PE100 resin, having a Minimum Required Strength (MRS) value of ≥ 10.0 MPa, at a service temperature of 20°C for a minimum design service life of 50 years.

The pipes and fittings shall be manufactured in accordance with EN 12201:2011, ISO 4427 / ISO 4437 or other acceptable International Standard. The Pipes and Fittings shall comply with the following:

Pipes:	Material:	Polyethylene PE100 (MRS100), density ≥0.95 kg/dm³
	Colour:	**Blue** **Black with Blue stripes** **Black with Blue outer coextruded layer**
	Pressure Rating:	SDR 17 – PN10 SDR 11 – PN16
	Supply Lengths:	All pipe sizes up to and including OD 75 mm shall be supplied in coils of 50 or 100 meters. All pipes, OD 90mm and above shall be supplied in straight lengths not exceeding 12metres.
Fittings:	Material:	Polyethylene PE100 (MRS100), density ≥0.95 kg/dm³
	Colour:	Black or Blue
	Type of Joint:	Electrofusion / Spigot type for Butt Fusion / Compression (for sizes 110mm and below)
	Pressure Rating:	SDR 17 – PN10 SDR 11 – PN16

Diameters: *as per EN 12201-2*

PE 100 (MRS10), σ_{all} = 8.0 MPa			**PN 10.0**		**PN 16.0**	
Outside Diameter (d) (mm)	**Tolerance on OD (mm)**	**Maximum Ovality (mm)**	**SDR 17 Series 8**		**SDR 11 Series 5**	
			Min. WT (mm)	**Tolerance (mm)**	**Min. WT (mm)**	**Tolerance (mm)**
16.0	0.3	1.2	-	-	-	-
20.0	0.3	1.2	-	-	**2.0**	0.3
25.0	0.3	1.2	-	-	**2.3**	0.4
32.0	0.3	1.3	**2.0**	0.3	**3.0**	0.4
40.0	0.4	1.4	**2.4**	0.4	**3.7**	0.5
50.0	0.4	1.4	**3.0**	0.4	**4.6**	0.6
63.0	0.4	1.5	**3.8**	0.5	**5.8**	0.7
75.0	0.5	1.6	**4.5**	0.6	**6.8**	0.8
90.0	0.6	1.8	**5.4**	0.7	**8.2**	1.0
110.0	0.7	2.2	**6.6**	0.8	**10.0**	1.1
125.0	0.8	2.5	**7.4**	0.9	**11.4**	1.3
140.0	0.9	2.8	**8.3**	1.0	**12.7**	1.4
160.0	1.0	3.2	**9.5**	1.1	**14.6**	1.6
180.0	1.1	3.6	**10.7**	1.2	**16.4**	1.8
200.0	1.2	4.0	**11.9**	1.3	**18.2**	2.0
225.0	1.4	4.5	**13.4**	1.5	**20.5**	2.2
250.0	1.5	5.0	**14.8**	1.6	**22.7**	2.4
280.0	1.7	9.8	**16.6**	1.8	**25.4**	2.7
315.0	1.9	11.1	**18.7**	2.0	**28.6**	3.0
355.0	2.2	12.5	**21.1**	2.3	**32.2**	3.4

PE 100 (MRS10), σ_{all} = 8.0 MPa			PN 10.0		PN 16.0	
Outside Diameter (d) (mm)	Tolerance on OD (mm)	Maximum Ovality (mm)	SDR 17 Series 8		SDR 11 Series 5	
			Min. WT (mm)	Tolerance (mm)	Min. WT (mm)	Tolerance (mm)
400.0	2.4	14.0	**23.7**	2.5	**36.3**	3.8
450.0	2.7	15.6	**26.7**	2.8	**40.9**	4.2
500.0	3.0	17.5	**29.7**	3.1	**45.4**	4.7
560.0	3.4	19.6	**33.2**	3.5	**50.8**	5.2
630.0	3.8	22.1	**37.4**	3.9	**57.2**	5.9
710.0	6.4	24.9	**42.1**	4.4	**64.5**	6.6
800.0	7.2	28.0	**47.4**	4.9	**72.6**	7.4

Performance Characteristics

The pipes shall have the following basic minimum performance characteristics:

Paramete	Unit	Value
Average Density as per ISO 1183	Gm/cm^3	≥ 0.95
Melt Flow Index MFI 190°C / 50N as per ISO 1133	Gm/10 min.	0.4-0.55
Minimum Tensile Strength	N/mm^2	25
Elongation at Break	%	$\geq 600\%$
E-Modulus (Modulus of Elasticity)	N/mm^2	1200
Minimum Radius of Curvature at 20°C		25 x OD
Linear Coefficient of Thermal Expansion (VDE 0304)	$°K^{-1}$	1.3×10^{-4}

Marking and Identification

Pipes shall be clearly and indelibly marked to show the following:

- Name of Manufacturer / Brand
- Nominal Diameter x Minimum Wall Thickness
- Material Classification (i.e. PE100)
- Standard Dimension Ratio and Pressure Rating (SDR17 PN10 or SDR11 PN16)
- Reference Standard of Manufacture (e.g. EN 12201)
- Date of Manufacture

Transportation, Storage and Laying of Pipes and Fittings

Before transporting HDPE pressure pipes the loading surface of the vehicle must be cleaned and free from projecting nails, screws or other sharp objects. The bottom layer of all pipes must as far as possible be in contact with the loading surface throughout their entire length and not project beyond it. The pipes must be secured from slipping and shall not be pulled over sharp edges when loading and offloading. Pipes shall not be dragged along the ground.

Pipes, fittings and coils shall be stored in such a way that they are completely protected from direct sunlight. When covered, they must be well ventilated to avoid accumulation of heat and resultant deformation. Transparent coverings shall not be used. The storage location shall be flat and shall,

for pipes, support the pipes throughout their length. Stones and sharp objects shall not be present. Pipes shall not be stacked to a height exceeding 1m. The pipes must be secured at the sides to prevent them from rolling. Contact with harmful materials shall be avoided. As far as possible, coils shall be stored in a horizontal position. The area shall be free of stones and sharp objects. If stored upright they must be secured to avoid tilting.

Prior to laying in trench the bed of the trench must provide support throughout the entire length of the pipe. The pipe shall not be laid directly on cohesive, rocky or stoney soil. Such material shall be over excavated to a depth of not less than 0.1m and shall be removed and replaced by non-cohesive soil or a special pipe support. This shall initially be recompacted and then the surface loosened on the day of and prior to laying.

Pipes supplied in coils and of up to 63mm diameter may be unrolled with the coil in the vertical position. For larger diameters an unwinding device shall be used. A turnstile can be used with the coil laid in a horizontal position on it or with the coil mounted vertically on a slow moving lorry. The pipe shall never be removed from a coil in a spiral manner as this may cause kinking. Should kinking nevertheless occur the Contractor shall cut the pipe on either side of the kink, prepare the ends, and then use an approved joint after laying. All costs of dealing with kinking shall be to the Contractor's expense. A minimum bending radius of 35 x the diameter shall be observed.

Joining Methods

A. Butt Fusion: The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians.

B. **Saddle Fusion**: Saddle fusion shall be done in accordance with ASTM F 2620 or TR- 41 or the fitting manufacturer's recommendations. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past year on the equipment to be utilized on this project. [Saddle fusion is used to fuse branch saddles, tapping tees, and other HDPE constructs onto the wall of the main pipe] (ASTM F905).

C. Socket Fusion: Molded socket fusion fittings are only to be used for joining of HDPE pipe from 1/2 inch to 2" in size. Socket fusion shall be done in accordance with ASTM F 2620 or the fitting manufacturer's recommendations. Socket fusion is the process of fusing pipe to pipe, or pipe to fitting by the use of a male and female end that are heated simultaneously, and pressed together so the outside wall of the male end is fused to the inside wall of the female end. Qualification of the fusion technician shall be demonstrated by evidence of socket fusion training within the past year on the equipment to be utilized on this project. [*Socket fusion is not widely used, and the specifier may decide to prohibit its use*]

D. Electrofusion: Electrofusion joining shall be done in accordance with the manufacturers recommended procedure. Other sources of electrofusion joining information are ASTM F 1290. The process of electrofusion requires an electric source , a transformer, commonly called an electrofusion box that has wire leads, a method to read electronically (by laser) or otherwise input the barcode of the fitting, and a fitting that is compatible with the type of electrofusion box used. The

electrofusion box must be capable of reading and storing the input parameters and the fusion results for later download to a record file. Qualification of the fusion technician shall be demonstrated by evidence of electrofusion training within the past year on the equipment to be utilized for this project.

E. Mechanical:

- Mechanical connection of HDPE to auxiliary equipment such as valves, pumps, and fittings shall use mechanical joint adapters and other devices in conformance with AWWA Manual of Practice M55, Chapter 6.
- Mechanical connections on small pipe under 3" are available to connect HDPE pipe to other HDPE pipe, or a fittings, or to a transition to another material. The use of stab-fit style couplings is allowed, along with the use of metallic couplings of brass and other materials. All mechanical and compression fittings shall be recommended by the manufacturer for potable water use. When a compression type or mechanical type of coupling is used, the use of a rigid tubular insert stiffener inside the end of the pipe is recommended.
- Mechanical couplings that wrap around the pipe and act as saddles are made by several manufacturers specifically for HDPE pipe. All such saddles, tapping saddles, couplings, clamps etc. shall be recommended by the manufacturer as being designed for use with HDPE pipe at the pressure class listed in this section.
- Unless specified by the fitting manufacturer, a restraint harness or concrete anchor is recommended with mechanical couplings to prevent pullout.
- Mechanical coupling shall be made by qualified technicians. Qualification of the field technician shall be demonstrated by evidence of mechanical coupling training within the past year. This training shall be on the equipment and pipe components to be utilized for this project

F. Joint Recording: The critical parameters of each fusion joint, as required by the manufacturer and these specifications, shall be recorded either manually or by an electronic data logging device. All fusion joint data shall be included in the Fusion Technician's joint report.

1704.18. POLYPROPYLENE PIPES

Propylene co-polymer pressure pipe shall comply with the relevant provisions of BS 4991 and DIN standards and, where it is to be in contact with potable water, shall be Series 1.

Polypropylene pipes shall be available in diameters from 12mm to 1400mm and shall be suitable for working use at temperatures up to 90°C, and withstand short-term use at a maximum 110°C.

1704.19. Ductile Iron Pipe Work

General

Ductile iron pipes and fittings for water supply shall comply with BS EN 545 (1995). Pipes and fittings shall have spigot and socket joints unless otherwise specified. Pipes shall be class K9.

Spigot and socket flexible joints shall be of the push-fit type with gaskets of ethylene propylene rubber (EPDM).

Corrosion Protection

Pipes and fittings shall be protected externally with an extruded polyethylene or polyurethane coating complying with DIN 30674. Pipes and fittings shall be lined internally with centrifugally applied cement mortar and complying with DIN 30674. Joint areas shall be coated with epoxy or polyurethane to DIN 30674. All lining and coating materials shall be approved for contact with potable water by an internationally recognized body like the Drinking Water Inspectorate of UK.

1704.20. Steel Pipe Work

General

Steel pipes shall be manufactured to BS EN 10224 or AWWA C200 and shall be suitable for the pressure ratings required by the Contract. Fittings shall conform dimensionally to BS EN 10224, AWWA 208-59 or AWWA M11. Unless otherwise specified or necessary to meet the requirements of the Contract steel pipes shall be manufactured as follows:

a) DN300mm and below shall be manufactured to minimum of Grade L235 or API 5L Grade B
b) DN350mm and above shall be manufactured to a minimum of Grade L275 or API 5L Grade X42.

The pipes and fittings of diameter 600mm or less shall be supplied with push-fit spigot and socket type joints with integral gasket of EPDM rubber or similar to BS EN 10224 or BS CP 2010. Pipes greater than 600mm shall be supplied with ends cut square suitable for use with flexible couplings and the external weld ground back sufficiently.

Each pipe shall be supplied complete with a coupling for jointing.

Corrosion Protection

Steel pipes and fittings shall be protected externally at the manufacturer's works with fusion bonded epoxy resin in accordance with AWWA C213. Pipes greater than 600mm and all fittings shall also be lined internally with fusion bonded epoxy. Pipes 600mm or less shall be lined with cement mortar to AWWA C205 or BS EN 10298.

All lining and coating materials shall be approved for contact with potable water by an internationally recognized body like the Drinking Water Inspectorate of UK.

Where required, the Supplier shall also price for the provision of an alternative 3LPE coating to DIN 30670 or AWWA C316 of a triple wrap system of fusion bonded or sprayed epoxy primer, an intermediate polymer adhesive layer and an extruded high density polyethylene coating in general conformance with ISO/DIS 21809-1 Class B as appropriate.

1705. ADDITIONAL PROTECTION OF JOINTS ON FERROUS PIPELINES

The completion of the internal and external protection at joints on ferrous pipes and fittings shall be carried out as per the manufacturer's recommendations and as detailed below, as appropriate, and shall be to the satisfaction of the Engineer to ensure the maximum life span of pipe and fittings. The costs thereof shall be deemed to be allowed for within the Bid.

In all cases where the pipe joint involves the use of nuts and bolts, the exposed threads of every bolt shall first be thoroughly cleaned and then coated with an approved zinc-rich paint allowed to dry for not less than 24 hours before proceeding with further protection as indicated below.

i. Where Pipes and Fittings are to be Concreted In (Wrapping Method)

The external protection to pipes and fittings jointed by mechanical couplings, flanged joints, "Tyton" type, or Bolted Gland joint, or similar shall be completed by wrapping the joint with approved petrolatum tape, prior to which the area shall have been cleaned by an approved proprietary paste and the area protected by an approved proprietary mastic. It shall then be wrapped in PVC 'outerwrap' or similar material.

The whole joint shall first be thoroughly cleaned removing all loose rust and extraneous matter and the approved proprietary paste rubbed well over the whole of the joint and for a few centimetres either side of the joint over the pipe sheathing. A liberal amount of paste shall be left around all bolt heads, narrow cavities, etc.

The approved proprietary mastic shall be applied to cover all bolt heads and nuts, forced into the annular gap between the spigot and socket in the case of 'Tyton' type or bolted gland joints, formed as a triangular fillet against the face of socket or flanges and filled in all gaps and abrupt change in contour to provide an even contour for wrapping.

The approved petrolatum tape shall be applied circumferentially, starting and finishing at the top of the joint care being taken to smooth and eliminate any air pockets and to form the tape well into all angles and changes in contour. The tape should extend on to the pipe sheathing on either side of the joint by at least 50 mm and the tape should be applied with a minimum overlap of 25 mm.

An outer wrapping of 'PVC Outerwrap' shall be finally applied over the approved tape. This wrapping should extend at least 50 cm on to the pipe sheathing and should be applied with a minimum lap of 50 mm. All the above mentioned materials shall be provided by the Contractor and deemed covered in his rates.

ii. Additional Protection to Flexible Couplings/ Flange Adaptors in Chambers and/or above Ground

Such mechanical joints e.g. flexible couplings, flange adaptors, etc. in chambers and/or above ground shall have been factory epoxy coated and shall after installation be cleansed by brushing away soil and then shall have an approved mastic blanket moulded around them so as to provide a contour suitable for wrapping the component with an approved petrolatum anti-corrosion tape suitable for tropical climates which shall then be done so as to achieve a clean and neat good tape finish.

iii. Protection to Flexible Couplings and Flanged Adaptors Fitted to Epoxy Coated Pipe Spigots

Where factory coated flexible couplings have been used on pipes whose exposed surfaces beyond other protection materials have been factory protected using epoxy, then such joints shall be site protected by a polythene outer wrap sheathing of minimum thickness 200 microns that shall extend

beyond the pipe epoxy coating by at least 50 cm. This outer wrap shall be double strapped using a non-metallic strap to each pipe end beyond and not to the epoxy coating.

1705.1. GRP Pipes and Specials

Glass Reinforced Plastic piping shall be in accordance with SRN 317.

1705.2. Galvanised Pipes and Specials

All piping shall conform to SRN 823 and SRN 903 for "Medium" Piping. The pipes shall be screwed and socketted, coupled or flanged.

All specials shall be of such dimensions as will mate with the piping supplied. Screw down stop valves shall conform to SRN 826. Barrel nipples shall conform to SRN 823 and all other specials shall conform to SRN 824.

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

1705.3. Concrete Pipes and Specials

Concrete pipes and specials shall comply with the requirements of SRN 840. They shall carry the relevant Standards Institution registration certification trade mark, or test certificates shall be furnished by the manufacturers.

1705.4. Concrete Porous Pipes

Concrete porous pipes shall comply with the requirements of SRN 410: Concrete Porous Pipes for Under-drainage.

1705.5. Asbestos Cement Pipes and Specials

All piping and bends shall be plain ended suitable for use with flexible couplings and shall comply with the requirements of SRN 401. Fittings shall be of asbestos cement or cast iron complying with requirements of SRN 201, or mild steel complying with SRN 210.

Where possible, fittings shall have plain ends of an external diameter equal to that of the asbestos cement pipes and shall be suitable for use with asbestos cement, cast iron or mild steel mechanical joints. Where compatible external diameters of fittings and pipes cannot be supplied, suitable stepped couplings of approved manufacturer shall be used.

Flexible couplings shall be supplied complete with bolts, nuts, washers and joint rings as may be required. All metal parts of the joints shall be adequately protected with rust-proof paint.

The couplings shall, if required by the Engineer, be protected from corrosion by wrapping with Denso paste and tape or by some similar approved material.

The Contractor shall submit full details of the type of joint and a full description of the method of jointing.

The lengths of piping supplied shall be in accordance with SRN 401.

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

Unless specified, the pipes, joints and bends shall be coated internally with cement mortar lining complying with SRN 212. This lining should not impart any taste or odour to the water. External protection for pipes, joints and bends to be as specified in SRN 212.

Precautions shall be taken to avoid damage to the pipes and fittings during handling and storing and during laying, all to the satisfaction of the Engineer.

Where ferrules are tapped into the piping, saddles should be used, otherwise service connections can be incorporated by use of suitable long collar joints.

1705.6. Expansion Joints

Expansion joints shall permit expansion or contraction of the pipeline over a range of at least 50 mm either way, i.e. a total movement of 100 mm. Tie bolts shall be provided across the joint to restrict excessive movement of the joint. The expansion joint shall be coated internally and externally with the same material as the adjoining pipework. All bolts, nuts and washers shall be 316 stainless steel.

1705.7. Chemical Pipework

General

Each point of chemical application shall be fully piped from the appropriate tank or metering pump. Chlorine dosing pipes shall be run in rigid pipework.

All chemical pipes shall be colour banded to enable individual lines to be identified throughout their run.

The contract shall include for the provision of all necessary chemical suction, delivery, overflow and drain piping, fittings, support racks or trays and brackets for the plant supplied under the Contract.

The chemical hoses shall be provided with unions, as necessary, to provide for rapid dismantling and re-assembly in case of blockage and allow for easy cleaning. Drain cocks shall be provided at suitable points to allow for draining out of any chemical pipe before dismantling.

All pipework conveying chemical solutions or slurries shall be selected to suit the characteristics of the chemical being handled and also the environmental conditions in which they are installed.

Valves shall be of the diaphragm type, with bodies or linings suitable for the chemicals handled.

All chemical liquid wastes shall be conveyed to the nearest drain point.

Chemical Hose Trays

All chemical dosing hoses shall be run on cable trays of the heavy duty pattern constructed of mild steel and galvanised after manufacture. Trays shall have return flanges of minimum depth 25mm. Manufactured bends, fillers and tees shall be used throughout. Supporting steelwork shall be manufactured from a proprietary galvanised steel mechanical support system. The system shall comprise a U-section steel channel of minimum dimensions 40mm x 40mm and having an inner return flange. Fixing devices, support brackets etc., shall also be of proprietary make from the same manufacturer. Wherever horizontal tray runs are used, supporting brackets shall be cantilevered from vertical faces to facilitate the easy removal or addition of hoses.

Tray supports shall be arranged such that no perceptible sagging of trays is present when all hoses are in place. A minimum of 20% spare capacity shall be left on all trays.

Cut ends of trays and steelwork shall be painted with approved cold galvanizing paint before installation.

Hoses shall be laid flat on trays at a maximum of 2m intervals with adjustable self- tensioning nylon cable saddles. One bolt fixing saddle shall be used with two point fixings. The unbolted end shall employ a self-locking tongue slotted into the cable tray. All saddles shall be easily removable without cutting and be suitable for re-use. No more than 4 hoses shall be embrace with one saddle.

Stacking of hoses on trays shall not be permitted.

1706. PLATFORMS AND WALKWAYS

1706.1. General

All necessary platforms, toe-plates, ladders, stanchions, handrails, chains and all associated fittings, support structures and curbing shall be supplied to provide a safe and efficient installation.

1706.2. Steelwork

All mild steel item shall be protected to BS 5493 Section II by hot dip galvanizing after fabrication to BS 729 with a minimum thickness of 85 microns (0.0034") unless otherwise specified.

No cutting, drilling, bending, riveting, threading or similar operation will be permitted after galvanizing, and due care shall be exercised in transporting, handling and fixing galvanised metalwork to prevent damage to zinc coating. Under no circumstances shall damage to zinc coating be repaired with rust inhibiting paint.

1706.3. Platforms

Platforms as indicated on the Specification drawings shall be provided. All platform panels shall be individually secured to the supporting structure and be of suitable size and weight for ease of handling. They shall be cut and fixed to maintain a continuity of pattern.

Platforms, walkways and floor covers shall be adequately supported to prevent undue flexing and have supporting rebates with a minimum landing width of 30mm. The walkways, platforms and covers shall include all necessary supports not detailed on the Drawings.

Where the supporting structure is concrete, galvanised mild steel angle curbs shall be provided and securely grouted into rebates left in the concrete such that the tops of the panels are flush with the top of the concrete.

Normal access ways shall be suitable for a minimum uniformly distributed load of 5 kN/m^2 (105 lbf/ft^2). Where platforms and floor covers are specified for concentrated loads or machinery support, the uniformly distributed loading shall be not less than 15 kN/m^2 (315 lbf/ft^2).

Plated flooring shall be aluminum chequer plate having a minimum base thickness of 8mm with a non-slip tread pattern, secured to the supporting steelwork with countersunk screws, which shall be cadium plated when used with aluminum plate. For maneuvering small-wheeled items e.g. switchboards trucks, plain floor sheeting 8mm thickness shall be provided over specified areas.

Open mesh type walkways, platforms and covers shall be of aluminum or galvanized steel, suitable for a superimposed load of not less than 5kN/m2. Open mesh panels shall be trimmed with full depth nosing bar along all edges and bolted to each other when in place to help ensure a firm walkway. Panels shall be cut in such a way and fixing so as to provide a continuity of pattern.

1706.4. Hinged Covers

Hinged covers provided in platforms shall have a galvanised, fabricated steel framework, covered to match the surrounding floor strength and pattern, with strong durable hinges.

Covers provided for permanent man access shall be located as indicated on the specified drawings. They shall have a minimum clear opening of 750 x 750 mm and have a locking stay fitted, arranged so that in the fully open position, the stay will hold the cover open until released. Provision for padlocking the cover in the open or closed position shall be provided.

Covers for valve keys or other small openings shall be sized to suit the application and not include either stays or padlocking facilities.

1706.5. Ladders

Ladders shall be of mild steel construction except where they are subject to prolonged immersion in water where they shall be of stainless steel.

Permanently fixed ladders of the step type shall have flat section, non-slip, open type treads not less than 450mm wide between stringers, with handrails fitted to each side extended to meet the platform handrails at the upper end. Tread width shall be not less than 120mm with a pyramid pattern nosing.

Vertical or near vertical fixed ladders for emergency use shall be in accordance with BS 4211 with equally spaced rungs between 230mm and 260mm apart with a width between stringers not exceeding 400mm. Safety hoops shall be provided where ladders rise more than 2.3m from the ground or platform. The stringers shall be extended at least 1100mm above the upper platform, and suitably opened out for access, or where ladders are below manhole covers, a separate hand hold shall be fixed to the upper platform.

1706.6. Railings

Guardrails shall be provided for all platforms elevated greater than 500mm and the upper rail shall form the handrail. A knee rail shall be included an located approximately at mid- height.

Stanchions and rails shall be of mild steel or aluminum alloy tubing as specified, not less than 31mm overall diameter and tube thickness 10 SWG set in a twin-rail arrangement with the upper rail not less than 1.1m above the platform level or 900mm above the stringer pitch line for stair flight. Ball type tubular standards are to support the rails at not more than 1.5m centres and arranged so that there is a standard not more than 300mm away from any bend and 150mm from any rail joint. Rails are to be secured to prevent movement within the standards. Standards and rails shall be attached to the platform/walkway and not to any non-structural floor or toe plates.

Any roughness on the external surfaces shall be removed in an approved manner to produce a safe surface to the satisfaction of the Engineer.

A plastic coated finish shall be applied where specified and care should be taken to preserve from damage the plastic coating which may, if desired, be applied at a later date. The Contractor is to include all cleaning and derusting operations necessary.

Whenever possible, runs of guardrail shall be continuous and sharp vertical changes of direction shall be avoided. Handrails shall terminate in swept ends either to the wall or return to the knee rail by means of a U bend which shall not extend greater than 350mm beyond the centre line of the last standard.

1706.7. Safety Chains

Access openings in guard railing to ladders and platforms having a direct drop of more than 300mm shall be protected by a double row of safety chains of galvanised or electro-plated zinc mild steel 3 SWG x 3 links per 100mm complete with 'S' hook attachments at one end and permanently fixed at the other.

1706.8. Toe Plates

All platform and walkway frames shall have toe plates attached to the sides where guardrails are fitted. Only around cut-outs provided in floor plates shall the toe plate be secured to the floor plate by welding.

Toe plates shall be at least 100mm high and 6mm thick, any gaps between the toe plate and the floor should not exceed 15mm.

1706.9. Trench Covers

Trench covers shall be of aluminium or galvanised mild steel chequer plate (min 3mm thick) supported to prevent undue flexing and having suitable holes to allow removal by standard lifting keys. Support shall be by means of steel curbing rebates cast into the trench top edges, such that the top of the covers are flush with the top of the finished floor level and providing a landing width of at least 30mm.

Additional or alternative support for switchboards etc. shall be from at least 75 x 35 mm channel section cross bearers and transverse trimmers, fixed or cast into the floor and located to suit equipment fixings, access requirements and floor cover spans.

To prevent differential deflection, butt straps shall be fitted to the underside of floor plates which have no other support.

Edging curbs suitable for mild steel chequer plate shall be painted in red oxide primer, the curbing may be tapped to accept cover securing screws. Where aluminum plates are used in contact with any mild steel supports, a bitumen coating on the points of contact shall be used.

1707. CRANES AND HOISTS

1707.1. General

Cranes and hoists shall be of standard proven design in accordance with BS 466, rated for lifting the specified working loads, utilization and service conditions and shall be suitable for operation from the runway beams provided. Motions shall be motorized as specified with dual speed hoisting facility and controlled from a pendant push button unit via a crane control panel mounted on the gantry.

All operations, whether manual of electric, shall be controlled or performed from motor room floor level unless otherwise specified.

The lifting assembly shall be rated for the highest lift that could occur during installation and maintenance operations, including allowance for stiction.

The crane shall consist of a gantry or jib, crab and hoist assembly, ropes, block and hook together with the necessary running rails and all electrical supply requirements.

Chains used for lifting or travel shall be alloy steel and corrosion protected by an electro-deposited, zinc coated finish after manufacture. They shall not be hot dip galvanised.

Jibs or gantries shall be of plate or box girder design and securely attached to end mountings or carriages.

1707.2. Hoist

The hoist unit on travelling beams shall be mounted to provide the highest possible lifting facility whilst maintaining adequate clearance between the crab/hoist assembly and the building structure and fittings.

Hoist units fitted to single runway beams, fixed or jib mounted, shall be of the self- suspension type mounted on a single rigid trolley suitable for manual geared travel along the runway beam. Two end stops shall be provided on the beam suitable for the trolley provided. The trolley shall have ball or roller bearings grease packed for life.

The hook shall be fitted with a swivel and a safety catch and be capable of touching the floor and providing a minimum lifting height as specified.

In the case of electrically operated hoist the normal hoist speed shall be approximately 4 metres/min and the creep speed shall be approximately 600mm/min or nearest standards. An overload device and overwind limit shall be included to prevent dangerous overloads. Raise and lower limit switches shall be provided at the maximum and minimum lift positions. Instantaneous fail safe braking in the event of power failure shall be provided.

Where operation is by electric motor a power supply shall be provided under the contract. Power shall be taken form a feed in the main distribution panel forming a part of the works and a wall mounted fused isolator shall be provided at a suitable location approximately 1.5 m above floor level alongside the lifting installation.

Power transmission to the moving installation shall be by pick up shoe running along the underside of shrouded rails, suspended concertina cable running on slides or a rail or a cable from a self winding cable reeling drum. In the latter case the tension in the cable shall be controlled and support provided to prevent the cable dropping more than one metre below the crane rails(s).

1707.3. Testing

All lifting equipment shall be tested at the manufacturer's works and on site. Tests on site shall comprise a full load test, including, where applicable, deflection checks on beams. Where the contractor wishes to use lifting equipment forming part of the permanent works for installation purposes he shall have the equipment tested and be in possession of a valid test certificate before using the equipment. All equipment must be tested or retested within one month of handing over to the Employer. Test certificates shall be provided in triplicate. The Contractor shall be responsible at his own cost for the provision of all weights, slings and other equipment required for testing.

1707.4. Rating Plates

The SWL shall be clearly marked on the rating plate and shall be legible from the plant working level.

1707.5. Paint Finish

The finish colour shall be full gloss Yellow Colour No. 356 to BS 381C or equivalent reference 08 E 52 to BS 4800.

1707.6. Crane Access

Where clearance permits, provision for safe maintenance shall be provided in accordance with BS 466 and shall include a walkway across the span having a height clearance of 2m and be fitted with double-tiered handrails and toe boards.

1708. COMPRESSORS/BLOWERS

1708.1. Air Compressor

The compressor shall be an air cooled type capable of oil and dust free air delivery at the volume and pressures specified when directly or indirectly driven by an electric motor or diesel engine.

The compressor performance shall be in accordance with BS 1571 for the site condition and duty cycle specified and shall include the following components:

- Suction air filter/silencer;
- Solenoid operated unloader valve;
- Pressure relief valve;
- Non-return valve;
- Isolating valve;
- Low oil pressure switch (or pressure lubricated).

Where necessary, depending on load factor, the compressor shall include cylinder jacket and after cooler facilities for cooling the delivered air, the aftercooler having a suitable pressure relief valve and automatic drain valve.

1708.2. Air Receiver

The compressor shall deliver air into an air receiver manufactured in accordance with BS 5169 Class III Grade E or F, to accommodate the specified design pressure and internal volume.

The receiver shall incorporate the following items:-

- One safety relief valve;
- One automatic drain valve;
- One pressure gauge (o – bar);
- Pressure and temperature switched to suit the control;
- Inspection access to permit internal examination of the receiver;
- Lifting facilities as determined by the receiver weight.

The receivers shall preferably be located in low ambient temperature areas to minimize condensation and the inlet outlet pipe connections shall be arranged to promote air circulation.

1708.3. Separators

The air distribution main shall include a separator to remove suspended moisture in the air main.

1708.4. Compressed Air Filters

The air supply shall incorporate filters of the disposable element type as near as possible to the point of use.

Filtration shall be carried out using two filters in series, the first filter graded for course filtration and the second for fine filtration, or as defined in the Specific Requirements.

1708.5. Drain Traps/Strainers

Automatic drain traps shall be provided for air receivers, filters and separators. Strainers shall be provided for protection of the drain traps. Ball traps shall have cast iron bodies with stainless steel internal parts (Spiraax Sarco or equal).

1708.6. Air Pressure Control

The compressor shall be arranged to maintain the air pressure in the system within the specified limits by means of pressure switches in conjunction with unloader valves and timers to prevent prolonged off-load running.

The frequency of starting and stopping shall be within the limitations of the drive arrangement.

Where two compressors are operated on a duty/standby basis, the duty compressor shall operate whenever the low pressure switch closes and shall cease operation when the high pressure switch opens. Should the pressure fall to the standby low pressure, the standby compressor shall operate in conjunction with the duty compressor and shall similarly cease operation when the high pressure switch opens.

The circuits for the compressor motor starters shall be completely separate. Either unit shall be capable of duty or standby operation and periodically their modes will be reversed. The blower shall discharge continuously the specified free air delivery at specified suction and delivery pressures.

The blower shall be of the centrifugal or positive displacement rotary type with cast iron casings capable of delivering oil-free air. The blower shall be fitted with mechanical seals and incorporate a mechanical oil lubrication system, including an oil flow indicator, level indicator, pressure gauge, filling and drain plugs.

The design of the blowers is to be such that the noise level is kept to a minimum. The impellers shall each be equipped with heavy duty spherical roller bearing at each end. Gear end bearings shall be axially located on the inner and outer races to control thrust and maintain factory set clearances at all times.

The two timing gears shall be accurately machined to position the impellers in the impeller case and shall be secured to the shafts by locking kits. Gears shall be enclosed in an oil- tight housing.

The shaft sealing arrangement shall comprise a garter spring viton lip seal and a piston ring seal with an intermediate space vented to atmosphere.

Gears and gear end bearings shall be lubricated by a splash oiling system from oil maintained in the gear housing. Drive end bearings shall be grease lubricated or lubricated by a splash oiling system from oil maintained in the drive cover, depending upon gear size.

Each blower is to be direct driven through a flexible coupling, or indirectly via 'V' belts, by means of an electric motor, the complete assembly being mounted on a cast iron combination base plat. Both driver and driven units are to be dowelled or otherwise positively located to the base plate and substantial guards provided over all moving parts.

All covers and flanges associated with spigotted joints should be provided with easing screws if possible.

1708.7. Blower Accessories

Each blower shall include a tachometer, an adjustable weight operated lever type air relief valve, delivery pressure and suction gauges each with isolating cocks mounted on a panel secured to a

blower. An automatic unloader vented to outside atmosphere or an approved by-pass system is also to be included if this will assist starting.

The air relief valve is to be of double flanged cast iron construction with gunmetal trim. The adjustable weight shall have provision for locking to prevent any unauthorized interference.

Bosses shall be provided on each blower discharge pipe, upstream of the non-return valves, suitably tapped for connection by capillary tubing to pressure switches.

1708.8. Blower Filters

The filters shall be capable of handling the designed throughput of air with the minimum of pressure drop whilst excluding 99.7% of all particles down to 2 microns.

The filters shall be of the two stage type comprising a hand operated roller mounted first stage roll type element and a disposable cartridge type second stage having access from one side only. The first stage unit is to be mounted in a galvanized sheet steel case with easily removable covers, the roller handle being conveniently positioned for easy adjustment of the roll.

The second stage unit is to be mounted in a galvanized sheet steel case and the units connected by a transition piece, a further transition piece being arranged between the second stage and the silencer. Connections with isolation taps are to be provided on both sides of each stage and suitable manometers fitted to allow for measurement of the differential pressure.

Each unit shall be supported from the floor on substantial steel frames with welded plate feet.

1708.9. Air Silencers

Single inlet and outlet silencers shall be included for the blowers and manufactured of sheet steel, comprising a perforated inner tube and an outer galvanized casing, the space between being filled with a sound absorbing material. A flange is to be provided at each end, and all necessary supports extending to floor level are to be included. The silencers are to be designed for the minimum pressure drop.

1709. DIESEL ENGINES

1709.1. General

The engine shall be a cold starting 4 stroke water cooled, multi-cylinder in-line or "V" form, naturally aspirated or turbocharged and intercooled, totally enclosed industrial diesel of standard proven design, designed to run on liquid petroleum fuel to BS 2869 Class 'A' and incorporate all starting, lubricating, cooling, monitoring, alarm and shut-down systems suitable for automatic and continuous unattended operation.

The engine crankcase shall be fitted with a breather pipe and safety devices to provide protection in the event of an explosion.

Crankcase access panels shall be provided for maintenance/inspection where possible.

1709.2. Duty and Rating

The engine shall be rated in accordance with BS 5514 to provide the necessary torque and power output at a rated speed not greater than 1500rpm, to drive the specified load under the given site conditions.

1709.3. Flywheel

The engine crankshaft shall be fitted with a flywheel of suitable inertia to absorb speed variation to within the specified limits. The flywheel shall incorporate all necessary barring facilities and timing marks. Safety devices shall be fitted to prevent the engine starting when any barring gear is in use.

1709.4. Torsional and Cyclic Characteristics

The rotating system of the engine and ancillaries shall be statically and dynamically balanced during manufacture. Detachable components, e.g. fans shall either be separately balanced or permanently marked in a manner that ensures correct angular positioning.

For alternator drives, the coupling between the engine and the alternator shall be a flexible type of the manufacturer's standard arrangement and the torsional characteristics, cyclic irregularity, angular deviation and freedom from resonance shall comply with BS 4999, Part 142 and BS 5514 Part 5. The interchange of information between the engine and altenator manufacturers as directed therein shall be observed so as to ensure this.

1709.5. Governor and Speed Control

The engine shall be fitted with a governor suitable for automatically controlling the engine speed in accordance with class 2 of BS 5524, Part 4. Provision shall be made for variable hand speed control, emergency manual shutdown and an over-speed trip arranged to cut-off the fuel supply.

1709.6. Air Intake

The combustion air for the engine shall be drawn from the area specified, through an air filter having elements of a type commonly available.

Where combustion air is ducted from outside the building, the duct entry shall be fitted with a coarse mesh and fixed louvers arranged to prevent the entry of debris, small animals and the products of inclement weather.

1709.7. Fuel Systems

The engine fuel system shall consists of an engine mounted daily service tank, filters and fuel injection equipment with solenoid operated fuel cut-off valve, a gear driven mechanical high pressure fuel pump and isolating valves for the fuel supply to and from the service tank, all mounted adjacent to the engine.

Fuel leak off shall be piped back to the fuel filter assembly or the daily service tank. The high pressure fuel lines between the pump and the injectors shall be sheathed to contain and return any spillage to the daily service tank. Such return pipework shall incorporate a reservoir chamber with

a float switch to detect any accumulated leakage. Fuel atomizers shall be easily removable and interchangeable.

All fuel pipework on the engine shall be rigid tubing neatly dressed and clipped to avoid vibration interference with the maintenance procedures, have simple facilities for the relief of air locks and be spaced at least 50mm clear of any surfaces whose temperature exceeds 200ºC.

Fuel filters shall be full flow type fitted with re-useable mesh material. For continuously running, base load applications, filters shall be twin or triple compartment type with a change-over cock to enable one cartridge to be removed for cleaning without stopping the engine.

1709.8. Lubricating System

The lubrication system shall permit automatic starting of the engine and immediate load acceptance and consist of wet sump with integral engine driven gear type pump providing forced lubrication to working parts through an oil cooler and a duplex full flow filter. The filter shall use disposable elements commonly available and be of adequate capacity to allow continuous period of running without changing or cleaning.

Independent electric motor driven engine lubricating/pre-heating units shall be provided to give automatic periodic priming in accordance with the manufacturer's recommendation while the engine is at rest.

A hand priming pump shall also be fitted to enable all parts of the engine to be lubricated as required.

The cooling of lubricating oil on engines with engine mounted radiators may be by 'oil' section in the radiator. Engines with remote mounted radiators shall be provided with engine mounted water-to-oil heat exchangers for the cooling of lubricating oil.

The engine shall employ thermostatically controlled, liquid cooling using fresh water in a closed circuit, designed to suit the ambient conditions specified and comprise an engine driven circulating pump and a self-ventilating radiator. The pump shall also be capable of circulating sufficient coolant through the engine's lubricating oil cooler. Facilities for topping up and draining the system shall be provided together with a thermostat with a warming up by-pass.

A make-up header tank and automatic float valve shall be provided, together with all necessary connections to the specified supply source and the cooling system.

The cooling water shall include a quantity of anti-freeze to give protection to minus 10 degrees centigrade. An immersion heater and control thermostat shall be fitted to the system within the engine block to protect the coolant from freezing and shall operate from a 220V AC supply when the engine is not running.

Radiators mounted on engines shall be cooled by a 'pusher' type engine driven fan which draws air from the vicinity of the engine block and discharges it through the radiator core. They shall also include a suitable mounting flange for the attachment of air ducting trunking.

Remotely mounted radiators shall be cooled by an electric motor driven fan fed from and auxillary generator directly driven by the engine.

If the engine cannot be fitted with a suitable direct driven coolant circulating pump capable of maintaining adequate circulation through remote radiator, and auxillary electric motor driven pump shall be provided. This pump shall be arranged to operate from the same supply serving the electric motor driven radiator fan.

1709.9. Exhaust System

Each engine shall be fitted with a suitable exhaust system from the engine to the specified discharge point. The route shall be as short as site conditions allow and minimize the number of bends, which must be of a large radius. The system shall include primary residential type silencer, flexible and rigid pipework, roof cowl, flashing and all necessary ties and support. The primary silencer shall be supported from the engine set and shall have a flanged outlet incorporating a flexible stainless steel bellows section for ease of disconnection from the remainder of the exhaust system. The exhaust system shall be insulated with a non-asbestos material. Removable cladding shall be provided on the exhaust system where specified.

Support brackets shall allow for pipe expansion and where the pipe passes through walls, a sleeve or wall plate shall be fitted with an adequate hole clearance to prevent wall damage or fire hazard. Pipe flanges shall be fitted on each side of the wall.

The interior of the pipework and silencers shall be metallic aluminum spray coated to BS 2569 Part 2 Class 'D'. Where insulation is not applied, the exterior shall be similarly coated and shall be finished with a coat of high temperature aluminum paint from and approved manufacturer.

1709.10. Daily Service Tank

A daily service tank sized to hold at least twelve hours of supply fuel shall be mounted on a substantial steel frame above the set. The tank shall be totally enclosed, of non-galvanized material and have the following features:-

- Fuel inlet connection;
- Fuel outlet to engine with lockable valve;
- Overflow connection, piped with a fall to the drip tray or bulk supply tank as specified;
- Gasketted inspection plate on top;
- Fuel contents gauge (circular type) incorporating separate switches for control of fuel transfer pump
- Low level alarm (mounted on remote control panel).

The fuel inlet connections shall be piped to a conveniently placed quick release pressure coupling on the engine set for connection to the bulk fuel supply.

The fuel outlet within the tank shall be raised clear of the tank bottom to prevent water or sediment entering the fuel line.

The contents gauge shall be calibrated 0 – 100% in 10% graduations, 100% tank capacity (in ltres) being painted on the tank alongside the gauge. The drive from the float arm mechanism to the gauge and switch cams shall be transmitted by a magnetic coupling to ensure that no fuel can enter the switch compartment.

1709.11. Fire Cut-off Valves

Fire cut-off valves shall be incorporated in the fuel delivery pipe to each engine from the daily service tank and be located in an accessible horizontal position, coil uppermost, closest to the tank.

The valves shall be manually operated and solenoid maintained in accordance with BS 799 Part 7, the solenoid will be arranged to release in the event of a fire signal. The emergency handle shall be labeled with a conspicuous permanent notice reading:

"FIRE VALVE
PULL LEVER DOWN TO ISOLATE FUEL SUPPLY. LIFT TO RESET".

Where specified, a dump valve shall be fitted in the pipeline immediately beneath the daily service tanks so that the tank contents can be returned by gravity head to the bulk storage tank or a suitable external dump tank in the event of a fire signal. Electrically operated valves shall open when the operating solenoid is de-energised.

1709.12. Fuel Transfer Pumps

An electrically driven fuel transfer pump shall be provided for automatic filing of the daily service tank. Valves shall be installed on either side of the pump so that it can be removed without draining the pipework. The pump shall be located adjacent to the daily service tank or bulk supply tank as specified.

In addition to the above, a hand operated pump shall be installed, complete with adjacent isolating valves.

Where a dump tank is necessary because the service tank will not drain by gravity to the bulk tank, a hand operated pump shall be provided to enable the contents of the dump tank to be returned to the bulk tank.

1709.13. Fuel Supply

All necessary pipework, supports, isolating valves and fittings to connect the engine set to the bulk fuel supply or terminating point shown on the Specification drawings shall be provided.

A length of flexible hose fitted with a quick release pressure coupling shall be installed in the line at the engine set fuel connection point.

1709.14. Fuel Storage Tanks

Bulk fuel storage tanks shall be located as indicated in the Specification and drawings.

The tanks shall be manufactured in accordance with BS 799: Part 5 and fabricated from mild steel plate of 5mm minimum thickness with ends and flanged, electrically welded throughout and spatter removed. Galvanized materials shall not be used.

Each tank shall be provided with the following features:-

- a 480mm dia. raised manhole with a gasketted 8mm thick bolt on cover;
- fuel contents gauge;
- BSP threaded male bosses for filling, venting, outlet, drainage and

overflow connections;
- Provision of cleaning of the tank;
- Tank full warning alarm float and suitable boss.

The fuel outlet shall be at least 90mm above the drainage cock and preferably at the opposite end to the tank. The fuel supply line shall incorporate a mesh type filter, not coarser than 120 mesh, together with a weight operated, automatic fire shut-off valve located within the bund wall. The tank shall be positioned with a fall to the drainage cock.

Isolating valves shall be fitted within the bund wall to the outlet and drainage connections.

1709.15. Bulk Tank Fill Point

The tank filling access pipe shall be extended to the bund wall perimeter to be readily accessible for road tankers and shall be down-turned and capped to protect against the ingress of dirt and water.

The fill point shall be protected by a corrosion resistant enclosure having a padlocked cover to prevent unauthorized access. The tank full warning alarm shall be included within the fill point enclosure. This shall be designed to prevent overfilling the storage tank and be initiated by a float operated switch in the tank, arranged to give and audible and visible indication at the fill point when the tank is full.

The circuit shall operate at extra low voltage derived from a local control transformer suitable for a 220V 50Hz supply.

1709.16. Engine Starting

The engine shall be arranged for automatic starting and stopping arranged in conjunction with the overall control system. The engines shall not require pre-start priming of lubrication and shall be arranged for instant starting by batteries or compressed air as specified, the starter motor(s) engaging with the flywheel ring gear and disengaging automatically when the engine starts.

The system when fully charged, shall have sufficient capacity to crank the engine when cold, for at least three consecutive 10 second periods at 0ºC. A self contained charging system shall be provided to meet these requirements.

1709.17. Engine Instruments

An instrument panel shall be resiliently mounted on the engine complete with the necessary piping, connections, isolating cocks and indicators for the following:

- Cooling water temperature;
- Lubricating oil temperature;
- Lubricating oil pressure;
- Revolutions per minute;
- Exhaust temperature at each cylinder outlet;
- Running hours totaliser (showing 5 digits & non-resettable);

All instruments shall be scaled in approved metric units and gauges shall comply with C1 5.13 – Indicator gauges.

1709.18. Engine Protection

The engine shall be provided with alarm and shutdown features with shutdown conditions arranged to operate through the fuel solenoid, or as further detailed in the electrical specifications.

A manual fuel rack release knob shall be provided for emergency use.

1709.19. Engine Wiring

All wiring for engine mounted electrical components shall be carried out in suitable rated heat and oil resistant cabling fixed to the equipment where necessary and terminated in a wiring terminal box or boxes mounted in an accessible position on the bedplate, suitable for the necessary cabling to be extended to the local control panel. Separate boxes shall be provided for AC and DC circuits.

For full details of terminal boxes and auxiliary switches refer to the Electrical Specification.

1709.20. Engine Mounting Arrangement

Engine driven sets shall be either close coupled or open coupled as specified, via a flexible coupling. The driven unit shall have two independent bearings and all major items of the rotating assembly shall be dowelled to preserve alignment.

Close coupled sets shall be secured through anti-vibration mounts to a substantial fabricated steel base fixed to the floor.

Open coupled sets shall be fixed to a substantial fabricated steel base frame, secured direct to the floor, or where specified, secured through anti-vibration mounts between the base frame and floor.

The base frame shall be structurally designed and constructed to ensure maximum strength and may be used to mount engine ancillaries, set wiring marshaling boxes and control panels. The frame shall include jacking facilities where anti-vibration mountings are used. These shall not project to cause hazards to operating personnel.

Anti-vibration mountings shall be multiple neoprene bonded pattern, arranged to distribute without resonance the total weight and dynamic loads of the assembled engine set and auxiliaries supported on the base frame.

1709.21. Drip Tray

A drip tray, complete with drainage cock, shall be fitted within the confines of the base frame and shall have a capacity at least equal to that of the lubricating oil contained in the engine.

1709.22. Noise Attenuating Enclosure

The enclosure shall be removable pre-fabricated type designed to reduce the noise level by approximately 20 dB (A).

The enclosure shall incorporate access doors or panels such that routine maintenance can be carried out without removing the entire closure. It shall be possible to remove the enclosure without disconnection of the silencer mounted outside the enclosure. The operating sound pressure level of the set, measured in accordance with BS 4196 at a distance of 3 metres, with the exhaust silencer and the noise attenuating enclosure in position, shall be a maximum of 80 dB (A).

1710. GAS CHLORINATION

1710.1. General

Gas chlorination equipment for installation at pumping stations, reservoirs and water treatment works and other locations on the system generally come under one of two categories:

- Gas chlorination feeding into pressurized and gravity lines at locations where an electricity supply is available;
- Gas chlorination at those locations, such as water catchment works, outlets from reservoirs etc. where there is no electricity supply.

This specification covers both categories.

The Contractor is responsible for the safe design, provision and installation of the chlorination dosing system and associated safety equipment. The safety equipment required varies from site to site depending on site location, quantity of chlorine stored or dosed and type of equipment supplied. The Contractor shall access the requirements of each installation with respect to the following points:

- Ventilation system;
- Leakage detectors;
- Audio and/or visual alarms;
- Automatic shut down systems;
- Personal protection equipment;
- Procedures and training.

The equipment called for in this section are nominal requirements.

Water Meter

The water flow meter which may be of the turbine, magnetic flow, diaphragm or ultrasonic type, shall control the operation of the motorized control valve. It shall have the following characteristics:

Be suitable for fluids with up to 80 m/l solids particle content. It shall be designed for a range of water velocities from 0.5 to 3.0 m/s and shall transit a 4-0 mA signal.

Operate on a supply voltage of 220V or 110V – 50 Hz. Be equipped with a t rate of flow indicator.

Chlorine Detector

Where specifically called for or deemed necessary, gaseous chlorine detector units shall be fitted. The gas leak detector shall be used in conjunction with an alarm which shall be actuated if the gas concentration arises above 1 ppm or 3 mg/gas/cu.m of air.

The gas detector shall be a Dry-Cell type, consisting of an independent tank and detection cell located outside the tank. The tank capacity shall be sufficient to give 6 months operation. The detection cell (sensibility 1 mg/cu.m) shall be connected to an electronic measuring device located in a wall mounted box. In the presence of an oxidizing gas the detected cell shall generate a current proportional to the gas concentration.

The box shall have an electronic indicating device and shall give continuous monitoring.

When gas concentration reaches its maximum permissible limit the detector shall activate an acoustic alarm, and shall trigger the operation of a remote alarm, where fitted, the operation of the extractor fan and closure of the supply line valves.

A test push button shall be provided to allow the operation to be checked.

1710.2. Leak Detection, Residual, Free Residual and Total Residual Measurement

A bottle of liquid ammonia for chlorine vapour leak detection purposes and a measuring kit for quick determination of the concentration of the following shall be provided with every chlorination equipment installation.

- Free residual chlorine;
- Residual chlorine;
- Total residual chlorine.

1710.3. Installation of Equipment

The location of the chlorine bottles in the store shall be away from direct sunlight at all times. During transportation of bottles the Contractor shall ensure that gas bottles are not overturned and that safe handling procedures are adopted at all times.

Gaseous chlorine connections between system components shall follow the shortest and most direct route possible and shall be laid to falls.

Water and other piping shall not be laid immediately alongside gaseous chlorine piping in order to prevent cooling and condensation.

Only grease or other lubricant as recommended by the equipment manufacturer shall be applied to all removable fittings.

Where the chlorinator is installed remote from gas bottle the distance apart shall not exceed 10 metres.

The chlorinator vapour vent pipe shall be extended to outside the building away from inhabited areas. The vent pipe shall be covered with a mosquito net.

Chlorination equipment piping shall be secured to the wall by brackets with a minimum clearance of 100mm off the walls for painting and maintenance purposes.

1710.4. System Start-up

The procedure for putting chlorination equipment into services shall include:

- A bacteriological and physico-chemical analysis of the water to be disinfected;
- Determination of the chlorine demand of the water to be disinfected based on break point method;
- Adjustment of the chlorinator capacity to achieve, after 30 minutes of chlorine to water contact a residual concentration of 0.5 mg/l. A check shall be made by measurement of the concentration of free chlorine in water at a pre-determined location in the water distribution system.

In the case of a chlorinator controlled by an automatic residual chlorine measuring device, the indicated concentration shall be checked against the result of an analysis of residual chlorine in the water sample.

1710.5. Disinfection Control

Following start up of the chlorination system the contractor shall take five samples of disinfected water at five different locations situated at representative distances from the chlorination point so as to achieve effective control of the quality of disinfected water. The following tests shall be undertaken.

- Measurement of free chlorine (Type b1);
- Measurement of free chlorine in water.

1710.6. Pressure Testing of System

Prior to system start up all chlorination systems shall be pressure tested for leaks.

The system shall be tested with nitrogen of dry air at a test pressure 50% higher than the service pressure. Soapy water shall be applied to all joints and connections to facilitate detection of leaks.

The system shall be tested with chlorine. A rag soaked in liquid ammonia shall be brought to the vicinity of all potential leak points, leaks being evidenced by production of white ammonium chloride fumes. In the event of a leak, prior to effecting repairs, gas bottles shall be isolated and the lines drained through the dosing pumps.

IMPORTANT Procedure for Pressure Tests

- Open all valves one turn except gas bottle valves;
- Open gas bottle valves to achieve a system pressure of 1-2 kg/cm2 and
- close them again;
- Search for leaks with an ammonia soaked rag;
- In the event of a leak drain the lines with dosing pumps and repair the leak;
- Open gas bottle valve to achieve maximum system pressure;

- Repeat 4 and 5 above;
- When the system is leak free open gas bottle valves one turn.

1710.7. Tests on Completion

The tests on completion shall include the following:

- Injection rate;
- Injection pressure;
- Absence of leaks;
- Injected concentrations;
- Compliance with specification;
- Safety criteria and equipment;
- Such other tests as the Engineer may determine.

Site Procedures and Training

Training should be carried out with emphasis being given to safety precautions and methods of dealing with emergencies. Particular attention should be given to the following aspects:

- the hazards and characteristics of the material:
- safe methods of plant operation, including handling of the connection to supply systems;
- methods of maintenance;
- special operations, for example, plant shut down and start-up, methods of isolation and preparation of equipment for periodic maintenance and inspection;
- the location and operation of emergency shut-off valves;
- the procedures to be followed if releases occur;
- training in the use of all personal protective equipment supplied.

Operating Instructions

The operating instructions should cover each process of operation. Written operating instructions are required in English, for all routine and emergency operations, ranging from guide cards to simple operations to complete manuals.

Copies of instructions, which should include a flowsheet and indicate valves to be closed in an emergency, should be available in the working area for operators.

Emergency Arrangements

The emergency procedure should include how gas may be dealt with safely by site personnel. The procedure should cover various degrees of emergency and should be either supplied in written form or made available to employees so that they know the steps they are required to take. This procedure should include first aid and evacuation arrangements.

1711. MISCELLANEOUS EQUIPMENT

1711.1. Fire Hydrants

Fire hydrants shall be in accordance with SRN 509. They shall be for installation underground and shall be in accordance with SRN 509, corrosion resistant construction, ductile iron coated with approved epoxy coating.

The spindle shall be provided with a universal cast iron cap conforming to SRN 501.

The spindle of the fire hydrant shall be of the non-rising type and screwed so as to close the hydrant when rotated in a clockwise direction viewed from above. The direction of closing shall be clearly cast on the valve cap.

The flanged outlet of the outlet bend shall have a Bayonet Joint Outlet for a 63mm standpipe. The outlet of the hydrant shall be of the hooked type with hooks 112mm apart.

The outlet shall have a gun metal standpipe seating and be covered by a loose cast iron cap which shall be attached to the hydrant by means of a chain.

Both flanges shall be 63mm drilled to requirements of SRN 207.

The outlet bends shall be subject to a hydrostatic test in accordance with procedure set out in SRN 509 and shall be water-tight against a test pressure of 1.85 Pa. head of water.

1711.2. Marker and Indicator Posts

Marker posts shall be erected at changes in direction of water mains as directed by the Engineer. Indicator posts shall be erected at valves and other fittings as directed.

Marker and indicator posts shall be vibrated precast reinforced concrete and shall be embedded in concrete and painted in colours as indicated on the drawings or described in the specifications.

18.INSTRUMENTATION AND CONTROL

1801. GENERAL

1801.1. Design and Electromagnetic Compatibility

All circuits and equipment shall be designed in accordance with good engineering practices and particular care should be taken to ensure that no component shall exceed its maximum voltage/current/power ratings at any time, including during transient surges.

All instrumentation equipment shall be protected from interference emanating from radio frequency transmissions, either radiated or cable borne, such that it shall not cause malfunction of the system or damage to the components.

All equipment supplied shall not radiate any form of electromagnetic energy in amounts that might interfere with external equipment or instrumentation.

The latest standards on interference shall be followed and the principles of electromagnetic compatibility (EMC) applied to the design and application of the plant.

1801.2. Interrelation with Other Sections

Requirements given in other sections shall be applicable whether relevant to equipment or materials specified in this Section.

Thus indicator gauges, metres, enclosures, panel construction, finish, components, wiring, terminations, cabling requirements and environmental operating conditions shall be in accordance with the relevant clauses of the Mechanical and Electrical Sections unless specifically amended in this Section.

1801.3. Interrelation with other Contracts

Where the location, installation or connection of any components of instrumentation are arranged by the Engineer under other contracts, it shall be the responsibility of the Instrumentation Contractor to advise and provide all relevant information on such matters to the Engineer in order that the correct and proper performance of the Contractors instrumentation is not prevented or impaired.

1801.4. Temperature and Humidity

All supplied equipment shall function without error and shall be constructed of such materials or so treated as to prevent the formation of mould, fungus or any corrosion over the ranges of temperature and relative humidity specified in the specific clauses for this site.

1801.5. Enclosure Protection

Instrumentation and hardware mounted in the field shall be contained in suitable enclosures to provide ingress protection to BS EN 60529 rating IP54 indoors and IP65 outdoors as a minimum.

Sensors installed below water level or liable to submersion shall be rated IP 68. Where items are fitted in a panel or other enclosure, they shall preserve the design IP rating of that enclosure.

1801.6. Voltage and Frequency Tolerance

Equipment shall be capable of working from a supply whose voltage may vary ±15% and tolerate any transients that could be experienced in such an environment without programme corruption or system failure.

1801.7. Instruments

Each instrument and sensor shall be selected considering all the relevant performance parameters for the principle of measurement adopted, its intended use and the particular process in question.

All instrument output signals shall be volt-free, clean contacts rated at 220V AC 2A for digital and 4-20mA continuous proportional linear signal for analogue. Pulsed outputs suitable for integration counter drives shall be 24V DC.

1801.8. Inputs, Outputs and Signal Loops

Opto-isolation shall be provided on all input interfaces to card.

Digital signals shall be 24V DC with the power supply from either the associated power pack or the external instrument. Relays shall be used where more than one instrument including I/O are fed from a single signal.

Analogue signal shall be continuous linear scaled signals with a 4-20 mA operating range. Loops with instruments wired in series (e.g. panel mounted indicator and RTU input) shall have zener fitted across each subsequent instrument leg to ensure loop integrity.

1801.9. Terminals

Signal terminals shall be the disconnect type. Power supply terminals shall be shrouded and clearly marked with the appropriate warning tags. LED's shall be provided for faulttracing, if not supplied on the I/O cards. LED's in either case must be clearly visible from the front, with only the enclosure door open.

For each incoming screened cable, a separate earth terminal shall be provided for screen termination to earth.

All equipment, isolators, terminals and cables shall be clearly marked. 20% spare terminals shall be provided.

1801.10. Programming and Monitoring Unit

Hand-held portable devices shall be provided for the system allowing user configurable operation to enable the downloading or uploading of data or software and the local running of diagnostic software. For RTU plc's the device shall be fully compatible with the RTU and shall be supplied with:

1. Software to enable the development of programmes and the subsequent downloading to the RTU.
2. Software to enable full communications with the RTU and to:
    - upload data or alter data in the RTU;
    - access communications ports and I/O.
    - Full page process mimic display capability.

1801.11. Discrete Components

All discrete resistors, capacitors, switches, relays, diodes, transistors and other electronic devices shall comply with the BS 9000 series specification for components of assessed quality.

The Engineer's agreement must be sought before using components that are not certified, but it will remain the Contractor's responsibility to ensure that all components are suitable for the application.

Similar types of components shall be of the same manufacture and design wherever possible.

1801.12. Integrated Circuits

All integrated circuits shall be of a proven design and shall be clearly marked with the original manufacturer's identity and device number.

1801.13. Sub-Miniature Switches

Where DIL or other sub-miniature switches are used they shall be provided with a cover, or other means of protection, to prevent accidental switching during handling.

1801.14. Printed Circuit Boards

Printed circuit boards shall be made of glass fibre with copper trackwork, all exposed copper being tinned prior to assembly, and the board and components cleared of flux before a thin layer of clear varnish is applied for environmental protection.

The board and its components shall be identified by references relating to the corresponding circuit diagram which shall be printed on the component side of each board. Where a number of boards are mounted in a rack system, the rack and boards shall be clearly marked to identify each board to its particular position.

1801.15. Sockets and Connectors

The use of plug-in connectors for electronic equipment shall be kept to a minimum, and all circuit components including integrated circuit clips shall have soldered connections where this is permitted by the chip manufacturer.

Where sockets and connectors are incorporated in the design, they shall have self-cleaning, hard gold alloy plated, wiping action contact faces, and incorporate polarizing keys or similar means to prevent incorrect mating. Insulation displacement type connectors shall not be used.

All light current wiring having a cross-section of 1.0mm2 or less shall have tinned copper conductors.

1801.16. Test Facilities

The electronic equipment is to include built-in test facilities to permit the detection and replacement of faulty modules without the use of oscilloscopes, signal generators, or other sophisticated test equipment.

1801.17. Lightning Surge Protection

All telecommunication lines, data and signal cables and other items of equipment external to the building environment prone to damage resulting from induced surges due to lightning discharges, shall be fitted with lightning surge protection barrier devices at each end of the line to suppress and divert any transients likely to cause damage to the connected equipment.

All surge diverters/lightning arrestors fitted to telecommunication lines shall be of a design approved by the telecommunications authority.

Surge protection units shall be un-fused, solid state devices, designed to limit the transient over-voltages to mot more than twice the normal working voltage of the line. They shall have low in-line resistance and automatically return to normal operation after diverting a surge.

The units shall have provision for either DIN rail or individual panel mounting or direct bolted connection to a suitable copper earth bar.

The location of the units shall be arranged such that the earth connection shall be routed clear of the protected signal cables and have short, straight connections without sharp bends to the main earth points, using copper conductors not less than 16mm^2 csa and not greater than 5 metres in length to provide a low impedance path.

Surge suppression devices to provide protection from mains switching or other supply network disturbances shall be incorporated or fitted to all sensitive monitoring or control devices. They shall be designed to filter un-wanted transients and limit the 'let-through' voltage to less than twice the working mains voltage, between all conductors and each conductor and earth. Protection monitoring status indication shall be fitted.

1801.18. Uninterruptible Power Supply

A rectifier/battery/inverter system shall be rated and arranged to provide a 'no-break' supply to the specified loads.

The UPS shall incorporate maintenance free, sealed batteries and operate in a continuous mode to protect the connected loads from AC supply interruptions and irregularities to maintain a controlled output of 220V ±5% at 50 Hz ±1% for up to 30 minutes.

The unit shall incorporate a static by-pass switch arrangement such that in the event of failure of the inverter, it shall automatically transfer the load to the bypass supply with no loss of continuity in supply. This unit shall monitor the mains and output frequencies to maintain synchronization within ±0.5 Hz and ±5% voltage. Where these tolerances are not maintained, the

static by-pass shall be inhibited to prevent out of sync switching. Where generator sets are to be connected, a frequency tracking inhibit switch shall be included.

A manual by-pass switch shall also be provided to enable the UPS to be taken out of service for maintenance. No feedback shall be possible and any live parts shall be fully shrouded.

During mains failure, the battery will take over the supply via the inverter. On re- connection of the mains supply, the system shall automatically revert to its normal operating mode and the battery recharged to its full operating capacity.

Controls, metering and indications shall be provided on the panel front and arranged in an approved manner, including Start, Stop and Reset push buttons. Metering shall be provided for:

- battery voltage
- battery amps (centre zero)
- output voltmeter
- load ammeter

Status indications shall be provided for:

Normal Conditions – White	Fault Conditions – Amber
Mains on	Battery volts low
Boost charge	Charge failure
Inverter on	Inverter failure
By-pass supply available	Static by-pass inhibited
By-pass supply to load.	

All fault indications shall provide 'volt free' contacts for remote indication. On/Off control switches shall be provided within the panel for:

- Mains input
- Battery isolator
- By-pass supply
- Boost charge

When isolating the UPS for maintenance, separate mains input and battery supply isolators shall be provided, interlocked such that the battery isolator cannot be closed before the mains switch is closed (to limit stress on the storage capacitors).

The UPS output shall be protected against under/over voltages and overcurrent during load transfers. The UPS shall be capable of satisfactorily withstanding an overload of 125% for 10 minutes and maintain output frequency stability of ±5% for 100% load changes.

Current limiting and over-voltage protection shall be included in the charger circuit together with charge rate adjustment to suit the battery manufacturer's recommendations, with automatic initiation of a timed boost charge as required.

The harmonics generated shall be restricted by suitable filters to be within the tolerances defined in Engineering Recommendations G5/3 "Limits for Harmonics in the UK Electricity Supply System".

The rectifier output shall also include filters to reduce DC ripple to the batteries to maximize battery life.

The UPS shall preferably be located within the Control & Monitoring Panel but where the panel is a separately mounted, free-standing unit, all construction component and finish details shall comply with those specified for the switch board panels.

1802. INSTRUMENTATION

1802.1. Instrumentation

Indicating instruments shall show the specified measured values in either electro- mechanical or electronic and analogue or digital form, as defined in the Specific Requirements.

Wherever possible, panel mounting indicating instruments shall be of matching size, appearance and orientation and suitably scaled, all in accordance with the general requirements for electrical panels.

1802.2. Strip Indicators

Strip indicators shall be provided for the specified functions and arranged as shown on the proposed panel layout.

The indicators shall be solid state electronic type employing a column of neon gas plasma bars, illuminated consecutively in proportion to the input signal. The scale length shall be at least 100mm and allow on-line span and zero adjustment.

All indications shall be driven from transducers or inputs giving analogue signals of 4-20 mA.

1802.3. Indicator/Recorders

Electro-mechanical indicator/recorder shall be a flush, panel, mounting, single/multi pen indicator/recorder, scaled and labeled as specified herein. The initiating signals for each pen and the trace colour(s) together with any event markers and/or alarm settings, shall be as specified.

Continuously running recorders shall run at a speed of 20mm/hour with date and time annotation at 4 hourly intervals. For intermittent running, as in storm pumping applications, the recorder chart speed shall be 60mm/hour and shall only be initiated when the level approaches the first pump start level and be stopped 30 minutes after the final pump cuts out. Starting and stopping times and dates shall be printed on the chart and each pump operation shall be individually annotated by means of a single trace for each pump showing its running time.

To provide minimum time lags between other channels on the recorder, dot print outs may be used where required.

The Z folded chart paper shall be 250/100mm wide, linearly scaled in half hourly divisions and the width shall be calibrated 0-50 divisions linearly or logarithmically scaled as specified to adequately show the normal range of operation and include the maximum possible signal. The chart shall run for a minimum period of 30 days and 24 spare charts shall be provided. Circular charts shall be 105mm wide, 7 day graduated.

Each channel shall provide a continuous ribbon strip visible indication over a calibrated scale (left hand zero) and an individually different coloured trace on the chart by means of either fibre tipped pens fed from disposable ink cartridges or electrical writing or sensitized paper.

Each input shall be separate and isolated from the conditioning amplifiers and all necessary computing modules shall be included in the unit to provide the required indications.

The following features shall be provided for the operator control, accessible from the front without withdrawing the unit during operation:

- Pen renewal (if relevant);
- Power on/off switch;
- Chart drive on/off switch;
- Chart replacement and adjustment.

Adjustable high and low, volt free alarm contacts shall be provided on each channel and incorporated into the control scheme as required to initiate the alarms as specified.

1802.4. Time Indicator

A mains driven synchronous type clock shall be suitable for front of panel mounting and resetting.

The display shall either be digital or analogue as specified and based on a 24 hour notation. The digital display shall be of white figures (not less than 55mm high), on a black background. The analogue display shall be dual scaled showing 0-12 hour black figures and 13-24 hour red figures on a white faced dial of not less than 220mm diameter.

The mains supply for the clock shall be via a suitable fused clock connector mounted in the panel, connected such that the clock is energized from the live side of the panel isolator.

1802.5. Capacitive Devices

Level monitoring shall be by means of a capacitance electrode suitable for the medium and environmental conditions specified such that the electrode capacitance varies in proportion to the immersed electrode length and be arranged to provide a 4-20mA output proportional to the specified level range on a scaled indicator giving a continuous read out.

Auxiliary switches shall be provided for high level alarm, low level alarm and control of external equipment. The position of all switches being adjustable over the level range.

Any fault in the electrode connection and in the electronic circuits shall provide an electrically isolated alarm signal for remote monitoring.

The electrode housing shall be a heavy duty pattern to IP 68 suitable for 2” flange mounting and incorporate a 20mm ET cable entry. The head shall be removable for cabling and servicing without disturbing the electrode mounting.

1802.6. Pressure Transducers

Pressure monitoring shall be by a transducer suitable for the medium and pressure/level range specified herein.

Each transducer shall be ranged to provide adequate sensitivity over the working range and be capable of sustaining a 400% overpressure without damage. They shall be of rugged and waterproof design, employing a pressure sensitive element within a stainless enclosure having an isolation diaphragm, suitable for either free wire suspension in the medium or fitted with a BSP thread for external connection to the relevant pipe tapping.

Suspended sensors shall be mounted in accordance with the manufacturer's instructions within a uPVC 'stilling tube' of sufficient nominal bore to enable easy withdrawal of the sensor.

Sensors shall be enclosed to IP 68, offer a long life and shall be supplied complete with a suitable signal cable to reach the approved point of termination transmitter-converter without intermediate joints.

The position of the equipment shall be such that withdrawal and installation can be achieved easily.

Cable entry shall be integral sealed assembly or by 20mm conduit entry into a sealed watertight terminal enclosure with provision for transducer venting.

A transmitter shall be provided either integral with the transducer or separately mounted as specified, suitable for operation from the mains or battery supply specified (not greater than 24V) and converting the signals received from the transducer to a 4 – 20 mA signal proportional to the ranged specified which shall be used to drive an indicator/recorder to give a continuous readout, and also to operate separate on/off pre-set adjustable points. The transmitter shall have provision for range and zero adjustment.

For use in hazardous areas as specified, the units shall be certified intrinsically safe Ex (1).

1802.7. Ultrasonic Devices

Flow or level monitoring by non-contact ultrasonic measuring devices shall incorporate ambient temperature compensation and adjustable datum setting facilities. Where specified, the output shall be computed to give a flow reading for the given parameters and/or control of pumps.

Transducer

The sensor head shall be protected to IP68, mounted to provide an unhindered beam path, prevent unwanted reflections, within easy reach of maintenance personnel and, where possible, be clear of flood conditions. For sewer or foul pumping sumps, the units shall be certified intrinsically safe Ex (i) for use in hazardous areas.

Signal Converter

The converter shall be suitable for operation from the specified power supply and convert the signals received from the sensor head to a 4-20 mA signal proportional to the range specified, to be used as detailed in the Specific Requirements.

The converter shall comprise a base unit and a programming device, all in a polycarbonate enclosure to IP 65. Communication between the programmer and the signal converter shall be in such a manner that the IP rate is not prejudiced.

A minimum of 3½ digit liquid crystal display shall be used to indicate key programming features, settings and output conditions, including flow calculations to BS 3680 for flumes and weirs.

Accuracy of the signal converter shall be better than ±1% of reading and shall have the following programmable outputs:

- mA proportional to user definable engineering units.
- SPDT relay contact output closing upon failure of the signal converter,
- lost echo or multiple echoes.
- Off SPDT contact outputs with independently set trip points. These
- outputs shall be programmed to energise upon high/low levels, rate of change or to allow a number of pump sequencing operations. Contacts rated at 5A 240V ac, non- inductive.
- Serial ports RS 232 for down-loading data.

1802.8. Electro-Magnetic Flow Meters

Electromagnetic Flow meters shall be sized and installed in accordance with the manufacturer's recommendations as approved by the Engineer, BS 5792 and BS 6739.

Flow meters shall be supplied with a calibration certificate. Electromagnetic flow meters shall be selected and sized to give a maximum velocity of between 1 and 3m/sec. The minimum velocity achieving the stated accuracy shall be not more than 0.1 m/sec.

The flow meters shall be of electromagnetic inductive type having a DC pulsed field with automatic zero error averaging and low power consumption. They shall have not moving or protruding parts nor cause any restriction in the flow path and be capable of setting adjustments without the need to stop the flow.

Each metering system shall comply with BS 5792 and comprise a flow sensor mounted in the pipework line and a signal converter, either integrally mounted or remotely located preferably within the main control panel.

The system accuracy shall be a maximum at normal operating flow with an error not more than 1% of the reading. When operating in the lower 30% of the meter range, the accuracy shall be within ±3%.

Flow sensors. These shall comprise electrodes located in ammeter tube which shall be of watertight construction, suitable for operation without loss of accuracy when totally submerged to a depth of 3 metres.

The meter tubes shall be made from a non-magnetic material lined with an inert material suitable for the medium and fitted with flanges to suit the pipework system, the lining material being applied such that it extends from the bore of the tube to fully cover the raised face of the tube flanges.

The measuring electrodes shall be continuously cleaned by means which do not interrupt the process flow or the measurement. A sensing electrode shall also be provided to detect when the flow meter is not fully charged with liquid.

The flow meter body shall be effectively bonded by non-corrodible, tinned copper braid links at each end, to the adjacent pipework to ensure a good connection between the body and the metered liquid, an earthing flange being inserted where non-conducting pipework is employed.

Signal Converter/Pulse Power Unit

These units shall be suitable for operation from the flow sensor into output signals having the following features:

Single flow rate range adjuster suitable for the flow sensor.

Independent output signals shall be provided for each flow direction as follows:

- +5/0/-5 volts d.c. signal for telemetry purposes with magnitudes directly proportional to flow.
- 4-20 mA current signal, to be used for indication of flow, quantity, etc.
- 24V impulse for integration counter drive.
- Works presettable system response time.
- Output driven downscale to zero on receipt of a 'flow meter empty' signal from the liquid sensing electrode.

The transmitter shall have the following programmable outputs:

- mA, proportional to use definable engineering units.
- off multifunctional SPDT relays. Individually programmed to allow a number of sequencing operations, rate of change or high/low flow indication. Contacts rated at 5A 240V ac, non-inductive.
- Serial port RS 232 for down-loading data.

Flow Meter Cabling

Where remote mounted converters are specified, cables shall be provided, installed and terminated between the sensor and converter/pulse power unit for the following purposes.:

- flow signal;
- reference signal;
- coil supply;

Such cables and sealing glands shall be suitable for submersible operation of the sensor to the depth specified. The length of each cable shall be as specified.

Spool Piece

A flanged steel spool piece shall be provided of the same diameter and length as the respective flow meter and flanged for insertion in the pipe should it be necessary to remove the flow meter.

Isolating valves shall be provided on either side of the flow meter.

1802.9. Differential Pressure Flow meters and Differential Pressure Switches

Flow meters of the differential pressure type shall be designed and installed in compliance with ISO 5167-1 or an Approved Standard. Primary devices shall be insertion probe type or carrier-ring type orifice assemblies with stainless steel orifice plate, or venture tubes shall include two sets of gaskets and fixing bolts for each primary device. Gasket materials shall be appropriate to the metered fluid and service conditions. Full details of orifice or venturi tube calculations shall be supplied.

Orifices shall be square-edged and concentric. The upstream edges of orifices shall be sufficiently sharp that the reflection of a beam of light from the edge cannot be seen without magnification. Drain holes shall be provided. The diameter ratio shall be between 0.20 and 0.70. Orifice assemblies shall have identification tags showing the direction of flow, orifice diameter and position of drain hole. The identification tag shall be welded to the plate before the orifice is machined.

Insertion probe type installations shall follow the equipment manufacturer's recommendations. The probe shall be mounted to a standard sired ferrule or flange plate and include appropriate 3-way value block.

Differential pressure transmitters and switches shall have over-range protection up to 1.5 times the maximum line pressure.

Location of these devices should be such that no turbulence shall interfere with the measurement of pressure either side of the device.

Signal Converter

The sensor shall be of the inductive type giving an output of 4 -20 mA proportional and the flow rate and a totaliser. The sensor shall be protected to IP 66 and having the following characteristics:

- Accuracy: <±0,25% of FSD between 25 and 100% of the flow measured.
- Stability: 6 months period: ±0,25% of FSD
- Voltage supply: 200 Vac
- Sensitivity: 0,005%/V at 50% flow and more

Differential pressure switches shall have contacts with differing "cut-in" and "cut-out" values. The nominal values at which differential pressure switches operate shall be fully adjustable over the whole range of the instrument and the set value shall be clearly indicated by means of a scale and pointer. Contacts of differential pressure switches shall be hermetically sealed.

1802.10. Variable Area Flow Meters

Variable area flow meters shall have glass or metallic tubes according to the particular application.

Metering tubes shall be removable for range change or cleaning without disassembling the meter or removing it from the line. Metering tubes shall have ends of equal cross-sectional area and if 0 ring seals are used, tube retainer springs shall be outside the fluid stream. End fittings shall be rotatable to any angle. Connections shall be horizontal and plugged vertical openings shall be provided for cleaning purposes.

1802.11. Ultrasonic In-line Flow Meters

The flow meters shall have flanged steel bodies and be without probes or pressure tappings which can foul or create a disturbance to the flow. The meter performance shall not be affected by emptying of the pipeline, and servicing shall be possible without the need to remove the meter from the pipeline.

The sensor tube and associated equipment shall be capable of withstanding occasional submergence in the flow metering chambers. The Contract shall include for the provision of a 230

V 50 Hz power supply from the nearest distribution panel, and a power pack unit if required for flow meter operation.

The converter/transmitter unit and the power pack unit shall be housed in a g.r.p lockable cabinet which may be either pedestal or wall mounted as appropriate to the meter location. The cabinets shall have heaters and thermostats if required to prevent condensation.

The Contract shall include for all internal wiring, and for cabling between the flow meter and cabinet. Where necessary cabling shall be screened to prevent interference.

The transmitter shall give an output signal of 4-20mA.

The span of the instrument shall be adjustable and the range of each instrument shall be chosen to unit the particular flow range. Meters shall be able to withstand surge flow above the normal operating range. Means shall be provided for check calibrating the meter on site.

The output signals from the flow meters shall be wired back for indication, integration and recording of flows with provision for future wiring to a telemetry outstation.

Meters on gravity lines will normally have flow, and although this could be low at some times of the day, in practice flow is unlikely to drop below approximately 20% of maximum. The meters on the pumping mains will have flow dependent on the operation of the pumps.

1802.12. Mechanical Flow Meters

Mechanical flow meters shall be volumetric, jet or in-line helical vane (Woltman) type to Standards ISO4064/BS 5728 EEC Specification with integral strainer. Meters shall be designed for minimum maintenance and shall incorporate best quality rotor bearings to ensure long working life.

Meter bodies shall be cast in spheroidal graphite iron to BS EN 1563. All internal parts shall be manufactured from non-corrodible materials.

Meters are for the measurement of potable water flow with a normal working temperature up to 30ºC and a maximum working pressure of 16 bar.

Meters shall be generally in accordance with the following table.

Meter Size (mm)	Q_{max}: PEAK Instantaneous Flow (minutes only) (m^3/h)	Qn: MAXIMUM Continuous Flow At ±2% measuring Error (m^3/h)	Qmin: MINIMUM Flow at ±5% Measuring error (m^3/h)
15	3.0	1.5	0.036
20	5.0	2.5	0.050
25	7.0	3.5	0.082
32	10.0	4.5	0.127
40	20.0	6.5	0.182
50	80	40	0.55
80	200	120	0.70
100	250	180	1.20.
150	600	400	3.00
200	700	550	5.00
250	1200	750	10.00
300	1500	1000	12.00
400	3000	2000	25.00

Measurement mechanisms shall be removable from the meter body without the necessity to remove the meter from the main. Meters shall be equipped with a register indicating flow in metric units a sweep hand and six figure counter. Dummy cover plates to seal the meter after the mechanism removal shall be provided.

Tapers shall be provided, or non-standard bearings and propellers, if required, to obtain the specified degree of accuracy at the specified flow rates.

The meters shall be suitable for working pressures up to 16 bar unless otherwise stated.

An extension drive and extended head shall be fitted to meters as required. The drive shaft bearings and gears shall be designed for long life under continuous operation, and normal wear shall not significantly affect the accuracy of the meter.

Meters shall have a circular dial and rate of flow indicator registering flow in litres/sec. A flow totaliser having at least six digits shall be incorporated in the head. The totaliser shall have a capacity of at least one year's flow at maximum flow rate. A multiplying factor in multiples of 10 may be used in conjunction with the totaliser if required, however, if this is the case, the factor shall be clearly marked alongside the register.

Meters shall be individually flow calibrated at the manufacturer's works and shall be guaranteed to within 2% of true flow within the rated range of the meter. Each meter shall be supplied with a calibration certificate.

The spare parts shall include as a minimum spare gearing and bearings for each size of flow meter used.

Where specified meters shall incorporate a pulsed output unit and portable data logger connection to enable flow rates to be monitored and transferred for plotting at a remote data port, microcomputer and printer for analysis. The pulse unit and data module shall be self supporting using dry batteries.

1802.13. Compound Meters

Compound meters for use on distribution systems shall comprise a main water meter capable of measuring the high flow rate, a smaller sized meter on a bypass for measuring the low flow rates and automatic change-over valve for controlling and apportioning the flow through the meters,

The change-over valve shall be of the hydraulically operated diaphragm/spring type. The main meter unit shall be equipped with a removable measuring element.

The change-over valve shall withstand a working pressure of 16 bar. The measuring range shall be in accordance with the table given below:

Size mm	50	80	100	150
Qmax: Peak flow (short duration)	70	150	250	350
Qm : Max Continuous flow at ±2% measuring error.	35	90	125	250
Qmm : Min. flow at 5% measuring error.	0.02	0.02	0.04	0.06

1802.14. Data Loggers and Software

Compatible data loggers shall be provided complete with interface cables and connectors for connection between the meter and the logger.

Data loggers shall be provided with a long-life battery, be of a robust construction and be waterproofed to IP 68 standard. They shall be capable of logging rates of flow in litres per second (l/s) and Cubic metres per hours (m3/h); and the totalized quantity in:- cubic metres (m^3).

They shall also be capable of downloading such data into an IBM compatible personal computer.

WOLTMAN TYPE METER

Data loggers for the Woltman Type meters shall have both digital and analog logging facilities.

COMPOUND METER

Data loggers for the compound meter shall be capable of digital logging of data from both meters and combining such data into an integrated whole for downloading into a PC.

SOFTWARE

Loggers shall be provided with software together with an interface cable complete with connectors for connection between loggers and the PC.

1802.15. Consumer water meters

General

Domestic water meters for house connection shall comply with BS 5728, KS 06-248 1, 2 and ISO 4064/2 & 2 /Add.1. In addition, it shall comply with the EEC Council Directive No. 75/33/EEC.

The domestic water meters shall be approved rotary piston volumetric type - Class C. The meter shall provide the specified flow accuracy when installed as detailed here below.

The domestic meters shall be supplied as a complete kit comprising the following items:

- Meter, Semi-positive rotary (grooved) piston volumetric type, calibrated in cubic metres;
- Meters are to be corrosion proof copper alloy or polymer plastic where specified;
- The outer body casing shall be of the split case type. The outer casing may consist of two parts which are screwed together and a watertight seal between the two.
- Isolating/disconnection valve;
- Union sockets;
- DN 15 BSP threaded inlet and outlet tail pieces complete with unions on each end, suitable for connection to galvanised iron pipe;
- Built-in strainer
- Built-in non return valve to prevent meter reversal

The meter shall be complete as a package for instant connection and use. The domestic meters shall have threaded connections.

Performance

The maximum flowrate (Q_{max}) is the highest flowrate at which the meter can function over limited periods without damage, and without exceeding the maximum permissible errors (+/-2%) and the maximum permissible value for loss of pressure (1 bar).

The nominal flowrate (Q_n) is equal to half the maximum flowrate, Q_{max}. It is expressed in cubic metres per hour and is issued to designate the meter.

At the nominal flowrate (Q_n) the meter should be able to function in normal use, i.e. in continuous and intermittent operating conditions, without exceeding the maximum permissible errors (+/-2%).

The minimum flowrate (Q_{min}) is the flowrate above which the meter must not exceed the maximum permissible errors (+/-5%), and is fixed as a function of Q_n.

The transitional flowrate (Q_t) is the flowrate which divides the upper and lower regions of the flow range and the rate of the maximum permissible error is +/-2%.

Performance Parameter		Nominal Diameter (mm)			
		15	20	25	40
Nominal Flow Rate - Q_n	m^3/h	1.5	2.5	3.5	10
Maximum Flow Rate.....Q_{max}	m^3/h	3	5	7	20
Minimum Flow Rate.....Q_{min}	l/h	15	25	35	100
Transitional Flow Rate.....……Q_t	l/h	22.5	37.5	52.5	150

Meteorological Classes

The meters performance specification shall be to ISO 4064/1 or BS 5728/1 Part 1, Class C or to equivalent internationally recognized Standard according to the value of Q_{min} and Q_t as shown in the following table:

Class	Qn=Less than 15m³/h	Qn=15m³/h or more
Class C Value of: Q_{min} Value of: Q_t	$0.01Q_n$ $0.015Q_n$	$0.006Q_n$ $0.015Q_n$

The meters must be able to retain their accuracy when installed in either horizontal, vertical or inclined planes.

Contractor shall provide certificates of the meteorological class of the meters offered.

Sizes

For each meter size designated the corresponding fixed set of dimensions must correspond to BS 5728, ISO 7858/1:1985 and no deviations from this shall be accepted. The lengths of water meters shall not exceed the following:

Parameter		Nominal Diameter (mm)			
		15	20	25	40
Leng	mm	165	165	199	300

Tightness, Pressure and Temperature Resistance

The water meter shall permanently sustain (without leakage, malfunctioning or permanent deformation) a minimum working pressure of 10 bar (DN 15 mm) or 16 bar (DN 20 mm) and be suitable for water temperatures up to 50 degree Celsius.

Headloss

Characteristic curves of head losses plotted against the rate of flow from the minimum flow rate shall be provided by the Tenderer. The meters shall show a loss of head not exceeding 1 Bar at Q_{max} and 0.25 bar at Q_n in accordance with ISO 7858/1:1985 and ISO 4064/1.

Materials

The materials used in the construction shall be designed to withstand raw and treated (potable) water and operate for at least 5 years without normal need for maintenance or repair and without the maximum error exceeding the specified limits.

Tenderer shall specify the optimum pH and the water quality for which the meters have been designed.

They must be constructed throughout of materials which are resistant to internal and external corrosion and if necessary be protected by some suitable surface treatment. All materials of the water meter which are in contact with the water flowing through the water meter shall be non-toxic and non-tainting. Water temperature variations within the working range shall not adversely affect the materials used in the construction of the water meter.

The outer body casing shall be of the split case type. The outer casing may consist of two parts which are screwed together and a watertight seal between the two. The meter body casing must be made from materials with a life expectancy under normal use in excess of 20 years.

The water meter shall be made with materials appropriate to each specific use. The body of domestic meters (DN15 - DN25) shall be manufactured from copper alloy or polymer.

The measuring element shall be of high grade polymer to ensure minimum wear and a high degree of reliability.

Counter

The indicator shall provide for reliable and unambiguous direct reading of the volume of water measured in cubic metres or in cubic meters and litres.

The indications of volume shall be by any of the two types as follows:

Type 1 By a row of inline consecutive digits in one or more apertures (drum counters); or

Type 2 A combination of drum counters for whole units of cubic meters and pointers on circular scales for fractions of cubic meters.

Drum counters shall be black for indication of a cubic metre and its multiples shall be red for indication of fractions of a cubic metre. Visible movements of the digits shall be upwards and the actual or apparent height of the digits on the drums shall be not less than 4 mm. The advance of a digital unit shall be completed while the next lower valued digit is within the last tenth of its travel.

The drums showing digits of lowest value shall move continuously in Type 1, and may move continuously in Type 2. Indicators with pointers (Type 2) shall rotate in a clockwise direction. The value of each division on the scales shall be expressed in multiples or sub-multiples of ten. Each scale shall be graduated in cubic meters or accompanied by a multiplying factor (x0.01, x0.1, x10, x100) according to the value of the scale. The symbol m^3 shall appear on the dial. The gear unit and the counter shall be combined and completely sealed.

The number drums shall be contained in a non-toxic fluid for lubrication and protection. The counter shall be placed in a window in the meter body and be placed so as to allow for ease of meter reading. Counter window shall be of minimum 7mm thickness. Black numbers on white shall denote cubic metres and white numbers on red shall denote litres. The counter shall reset to zero at a reading of not less than 10,000 m^3.

The indicator shall, as minimum requirement, record the following values:

Size of Meter(DN)	Minimum Registration (m^3)	Maximum Registration Before Se l Re- Set (m^3)
15mm	0.001	10,000
20mm to 40mm	0.001	100,000

Protection
A suitable in-built strainer (0.75 mm aperture and 2.844 mm^2 mesh area) shall protect the measuring mechanism and an in-built non return valve shall prevent meter reversal.

Marking
Each water meter shall be marked on the casing with the following information:

- Direction of flow of water on both sides of the meter
- Maximum flow rate ($3m^3/hr$)
- Individual Serial number (engraved)
- Manufacturer's name
- Country of Origin
- Year of manufacture
- WSP's name (max 10 letters)

Sealing
Water meters shall be provided with a means of sealing so that after sealing, both before and after the water meter has been properly installed, there shall be no possibility of dismantling or altering the water meter or its adjustment device without visibly damaging the seal. The meters shall be sealed subsequent to manufacture and before delivery to the purchaser.

The preferred method of sealing is by a corrosive resistant wire inserted through 2.5 mm diameter holes in the halves of the body, and secured by a circular metal seal impressed by a device which provides a unique imprint on the seal.

Packing
Packing shall be made of strong wooden crates, and inside such crate, each meter shall be packed in its own carton box.

Workmanship
The meters shall be guaranteed against defects in materials and workmanship for a minimum period of one year from date of delivery. Parts to replace those in which a defect may develop within such period shall be supplied without charge, piece for piece, upon the return of such defective parts to the supplier thereof or upon proof of such defects.

Meters should be designed for easy disassembly and re-assembly without the use of special tools or equipment and should be easy to maintain and repair. Meters designed to resist vandalism will be preferred.

SECTION 1, PART II

PARTICULAR SPECIFICATIONS

These Particular Specifications have to be read in conjunction with the General Specifications. The Clauses in the Particular Specifications will take precedence over the General Specifications. If there is any discrepancy between the specifications, BoQ and drawings the Contractor should refer the matter to the Engineer for clarification before proceeding.

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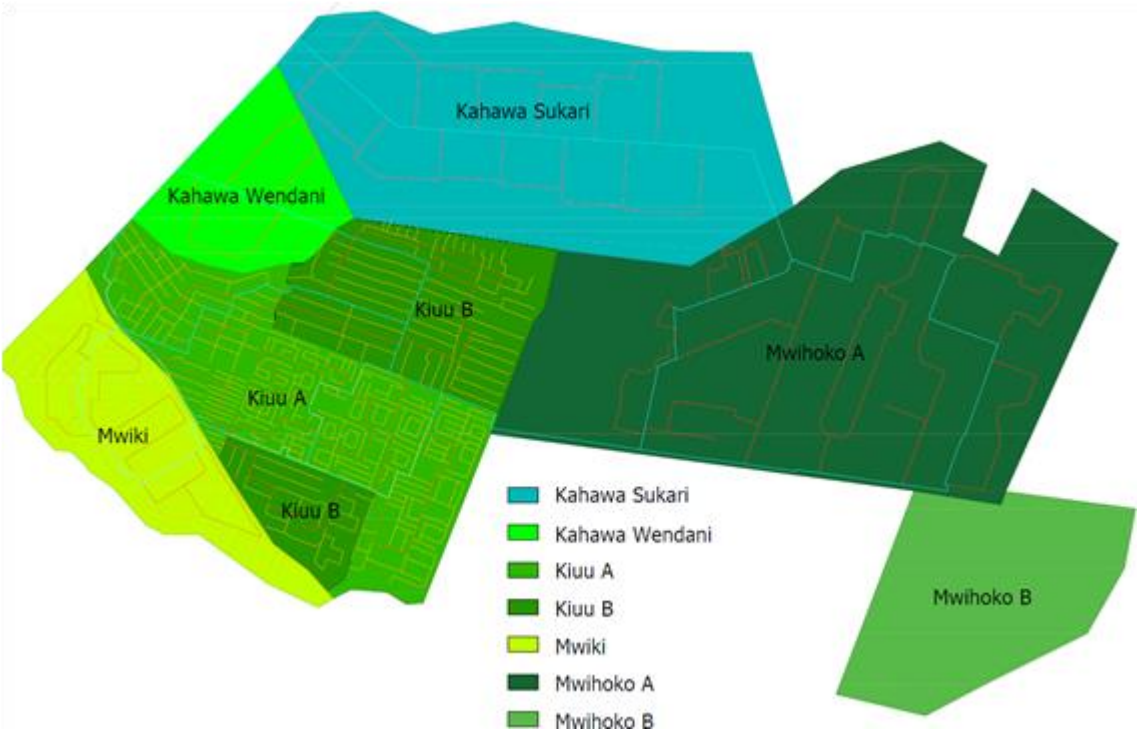
19. PROJECT SPECIFIC INFORMATION AND CONTRACTOR'S GENERAL RESPONSIBILITY

1901. PROJECT LOCATION

The Project is situated in the area of Mwihoko located directly adjacent to Nairobi metropolitan area, in Kiambu County.



The is no existing supply system in Mwihoko. Many people are not connected and rely on alternative sources such as borehole. The population of this area suffer from chronic water shortages, water rationing, high prices paid to water vendors, time spent queuing for water and incidence of water borne diseases.

1902. CLIMATE CONDITIONS

The Bidder must verify independently the climate conditions in the Project Area with the Kenya Meteorological Department, including rainfall, temperature, etc., and prepare the Work Plan accordingly.

1903. SCOPE OF WORKS

The Proposed Works for the Mwihoko Water Supply Project – Lot 4 are summarised as follows:

1) Water Distribution System

- Ring main to supply Mwihoko from the transmission mains, through Kahawa Sukari and round to Kiuu
  - 6 km of DN500 (OD 560-630)
  - 1 km of DN300 (OD 355)
- Additional Ring main to supply eastern part of Mwihoko

	○ 200m of DN500 (OD 560) ○ 5.5 km of DN300 (OD 355) • Secondary Distribution System in Mwihoko ○ 820 m of OD 225 ○ 12.4km of OD 160 • Tertiary Distribution System in Mwihoko ○ 60 km (OD 630 OD 110)
Consumer Connections	• Supply and install OD 25 – OD 63 HDPE for 4,000 number consumer connections

1904. ADDITIONAL CONTRACTOR'S RESPONSIBILITIES

Works will take place in narrow, congested streets and wayleaves. Therefore the Works Contractor must have experience of this and be qualified and experienced so as to be able to follow all environmental, social, H&S and traffic management requirements. This will require community liaison experience, and also dealing with informal service providers, with the support of the WSP.

Briefly, the Contractor should consider the following particular requirements and responsibilities:

- The Contractor shall have visited the site before submitting the offer in order to assess on-site the consistency and extent of work required, as well as the local operational and environmental constraints. The Contractor shall provide all labour, materials, equipment, tools and supervision necessary to undertake the works.
- Setting out and verification survey of pipeline routes is required to be done by the Contractor;
- The pipeline routing has been determined on site on the basis of available wayleaves, the shortest route, access for works and O&M and minimum difficulties. However, the Contractor will be responsible for the final pipe positioning, following the excavation of trial pits to uncover existing services and obstructions, and liaison with the relevant service providers and authorities. On this basis the Contractor will prepared shop drawings for approval for construction. Contractors rates are deemed to include this.
- The Contractor is generally free to propose alternative routings for the water supply system if he manages to find a more economical way, in which case he will have to submit detailed construction drawings including new quantities based on the units in the BOQ to the Consultant.
- Limited design works, including finalization of detailed river crossings works to ensure compatibility with current site conditions and structural design, workshop drawings, detailing of RC structures, bar bending schedules (e.g. valve chambers, support piers,) etc.; are required to be done by the Contractor.

- Design drawings must be submitted by the Contractor to the Client / Engineer to obtain the approval before ordering of any Plant, after which the works will commence.
- The Contractor must comply with the project specific Environmental and Social Management Plan, all according to NEMA Conditions. This shall include issues such as disposal of wastes, health and safety of workers, safety of public, maintaining access and avoiding nuisance to the public and property owners, conform to emissions requirements, drainage and excessive erosion, among others;
- Taking over will be carried out following the completion of testing, training and acceptance by the Engineer of the required documents, particularly O&M manuals and as-built drawings. Contractor's training must be based on the already approved O&M manuals. Essential spare parts will also be supplied to RUJWASCO and contact details of suppliers will be given for non-essential spare parts. Training for the raw water pumping station and treatment plant will include a test run period, under the responsibility of the Contractor, supervised by the Engineer. RUJWASCO will be given sufficient notice of the recommended numbers of operators and their required experience, to ensure that the required staff are available for training.
- The Client has no land available for Contractor's Camp or Camps. The Contractor will procure / rent adequate land for his camps including offices, workshops, stores, labour camp and other facilities within the vicinity of the Project Site. The Contractor will submit probable camp site(s) location details with the Bid.
- The Client has no land available for Storage of Materials including Pipes, Valves, Fittings, etc. The Contractor will procure / rent adequate land for proper storage and protection of all pipes, valves, fittings, etc. The Contractor will submit probable storage site(s) location details with the Bid.
- The Contractor shall be responsible for locating and protecting existing utilities and services, including existing bulk water supply trunk mains, electrical power cable routes (KPLC/Kenya Power), telephone (KPTC/Telekom) and other service providers), water and sewerage pipes (NCWSC), roads and drains (KeNHA, KURA, KERRA). In this respect, the Contractor shall be responsible for obtaining all Permits and Approvals, and in general complying with the requirements of the individual utilities and agencies.
- The Contractor will be responsible for a detailed condition survey along the pipeline routes, to be approved by the Supervisor. The condition survey must document the exact state prior to construction and propose monitoring for any vulnerable structures. Following installation of the pipeworks, reinstatement of all surfaces and facilities must be done as a minimum to the condition as prior to the works. The Contractor will be liable to repair any damage caused by the works, unless he can prove from the condition survey that he was not responsible.
- For general reinstatement in fields, earth, murram, etc. there will be no additional payment for reinstatement, it is deemed included in the excavation / backfill rates. Reinstatement in asphalt, concrete or stone paving will be paid extra, as required, and as included in the BoQ.
- Where mechanical and electrical equipment is to be installed in existing facilities the Contractor shall be responsible for protecting all existing plant, building works and services. Any damage caused by the Contractor to existing structures or services shall be repaired to the satisfaction of the Engineer. The Contractor shall immediately carry out essential repairs to any buildings, structures or services damaged by him during the execution of the Works and shall maintain them until such time as final reinstatement and repairs are completed.

- The Works Contractor will also be responsible for implementing strict controls during the works to ensure no contamination of the produced drinking water from the existing plant. The Contractor will only be permitted to proceed with works on the basis of Method Statements, approved by the Engineer.
- During the construction of the new water supply system, the Contractor will be responsible for not damaging the old, existing water supply system, which must remain functional. Therefore the Contractor should be prepared to temporarily support this existing system where it crosses the trench and must carry out temporary repairs if major leakage is discovered.
- The Contractor will also be responsible for the operation of all temporary installed pressure lines, pumping lines, etc., as well as for all newly constructed water supply pipes not yet taken over by the Employer.
- The water pipelines traverse along roads and densely populated commercial and residential areas. Working in these areas will require provision of safety barriers, warning signs and lighting, temporary accesses to properties, etc. The Contractor should include the cost of these under the relevant items in the BoQ.
- The Contractor shall be responsible for identifying and paying all Government Levies and Statutory costs such as training levy, licencing fee, etc. The costs of these are deemed to be covered in the Contractor's rates for the Works.

1905. CONDITIONS OF CONTRACT

The General Conditions are the "FIDIC Pink Book" – The MDB (Multi-lateral Development Banks) Harmonized Edition 2010 of the Conditions of Contract for Construction prepared and copyrighted by the International Federation of Consulting Engineers (*Fédération Internationale des Ingénieurs-Conseils*, or FIDIC), FIDIC 2010-All rights reserved.

1906. CONSTRUCTION PERIOD

The proposed construction period will be 6 months. Potential Contractors will note that multiple teams will be required to comply with this requirement, and they must provide documentation to demonstrate adequacy of resources in this respect. Additionally, potential Contractors must note that some disruptions to the scheduled work may be expected to occur during the rainy seasons. This must be allowed for in the works programme for implementation.

The Contractor's planning of the works shall consider the following:

i. Minimizing interference with AWSB / NCWSC / RUJWASCO operations;
ii. Procurement and supply times for materials and plant;
iii. Seasonal effects, especially related to work sites with low elevation and/or activities affected by rains;
iv. Co-ordination with other contracts if any;
v. Number and size of teams for different disciplines, and sequencing of activities;
vi. Number and type of Contractor's plant, equipment and tools;
vii. Any requirements of the Authorities regarding works on public roads
viii. Sequencing of activities to follow a logical plan. The Contractor shall not commence an activity and then leave it indefinitely in a state of partial completion. In particular, this applies to temporary disruption of existing operations, open excavations and demolition of existing structures.

The Contractor is responsible for confirming and fixing delivery times and costs of major items, such as pipes, fittings and plant, during the bidding period so as to guarantee that the Contractor can implement the project within the required time period and to the offered prices!

1907. SITE AND OTHER DATA

- Average temperature throughout the Project Area year is around 26^0C with minimum and maximum temperature varying from 15 to 32^0C respectively;
- Average rainfall is 1800 - 2500mm, with mainly two rainy seasons between March-May and October-Mid December but these periods can vary;
- The Project area varies in elevation between approximately 1800m and 1900m above mean sea level;
- There are several major hospitals within Nairobi. The Contractor will be required to maintain basic medical facilities and transport on site for emergency use;
- Design, manufacture and construction standards will conform to recognized international Codes and Standards as stated in the specifications. Conformity shall be with either BS, DIN or EN and in addition with ISO, as applicable, or other comparable standards with the same or more stringent requirements. Local Kenyan Codes and Regulations shall also apply.

1908. WAYLEAVE / EASEMENT FOR PIPELINE WORKS

The proposed water pipelines traverse along existing roads and are to be laid within the existing road reserves, as far as possible. Large sections of the roads and reserves also have other existing utilities such as fibre optic cables, electrical cables, water mains, sewer pipes, manholes and chambers. In some instances, the roads and reserves are paved with concrete / cabro / pcc slabs / asphalt. Sections of the roads and reserves may have encroachment by temporary structures. As-built details of the existing utilities are not available and Contractor will be required to carry out pilot excavation to determine the location and extent of the existing utilities. The Contractor will liaise with person(s) who have encroached within the road reserve, as per the project Resettlement Action Plan, and obtain clear right of way prior to commencement of work. Adequate planning and resources are required to minimise the disruption to Project Affected People, whilst also ensuring no delay occurs in the construction work programme.

Any additional space required for purposes of construction including working space for plant, other access, storage and movement of materials, excavated materials/filling, etc. will have to be appropriately arranged and paid for by the Contractor. In case of limited space in some sections, the Contractor may have to revert to manual excavation, double haulage of excavated material or any other means to execute the Works. To minimise disruption to residents, in areas heavily populated by traders, such as Ruiru market, excavated using machines/plants may not be possible and instead it should be done manually. The cost of all these exigencies will be deemed to be included in his rates for work.

The Employer will obtain and pay for the requisite permissions from Road Authorities - KeNHA, KURA, KERRA and Kiambu County Government to lay the pipes within the road reserves. However, the Contractor will allow in his rates all costs for conditions prescribed by the authorities during the construction of the pipeline and reinstatement of all reserve areas to the original condition.

1909. RESTRICTIONS ON USE OF ROADS

The Contractor shall not run tracked vehicles or tracked plant on any public or private road without the written approval of the Engineer and the responsible authority or owner and subject to such conditions as each may reasonably require.

The Contractor shall observe all weight and dimensions restrictions which apply to roads and tracks in Kenya and he shall comply with all reasonable restrictions which may from time to time be imposed by the Engineer. Where damage to roads and tracks is caused by the Contractor, this shall be repaired at the Contractor's expense. In particular, the Contractor shall fill potholes in roads with roadstone when these are deepened by his plant.

The Engineer shall have the power to restrict the Contractor's use of any roads, either in direction of traffic, speed of traffic or numbers of vehicles in order to preserve such roads or to make such roads safe for use by the general public.

1910. PREVAILING CONDITIONS

The Contractor is deemed to be fully familiar with local conditions and the potential effect (direct or indirect) on the planning and execution of the Works. The Contractor shall make his own studies / investigations in this respect. These conditions include, but are not limited to the following:

i) Climatic Conditions
There are generally two rainfall seasons, long rains between March and May and short rains between October and December.

ii) Access
The works are to be executed along roads and densely populated commercial and residential areas. The pipelines also cross a number of rivers/ streams. Bidders to visit the Project Areas and familiarize themselves with the specific conditions in each area.

iii) Services
The Contractor shall make provision for the temporary supply of all services necessary for the execution of the works, including water, electricity, communications including Internet, fuels and consumables etc. The Contractor shall make all such applications and payments as necessary in order to obtain these services.
The Contractor is deemed to be familiar with the levels of service provided, and shall make all necessary backup provisions (such as generator sets, water tankers, on-site storage for key materials, etc.) to ensure that delays are not experienced.

iv) Local Materials
The Contractor shall be familiar with the supply of local materials with respect to sources and location, delivery times, prices, quality and standards of products, sizes, quantities available, reliability and customer service, delivery capability, etc.

With respect to quarries and borrow pits, the Contractor shall be responsible for all fees, royalties, permits and other obligations concerning such activities.

v) Laws and Regulations

The Contractor is deemed to be familiar with all laws and regulations pertaining to the implementation of the Contract, including relevant National Design and Construction Standards, Environmental Regulations, Transportation of Heavy Equipment by Road, Minimum Wage and Employment Standards, Health and Safety Regulations, Establishing / Operating / Decommissioning of Borrow Pits, Disposal of Wastes, Procedures and Regulations related to Procurement of Imported Goods, Local Customs, etc.

vi) Local Labour
The Contractor shall liaise with Local Authorities (Chiefs, Labour Office, etc.) to recruit casuals and semi-skilled / skilled labour from the Project Area sites.

vii) Ground Conditions
The Contractor is deemed to be familiar with the site soil conditions, rock depths (whether hard or soft) including the presence of groundwater.

The results of the geotechnical investigations are included in Annex A to the specificaitons and must be assessed by the Contractor as part of the bid preparation and planning for the works.

In addition, the Contractor shall be aware of maximum flood levels in all Rivers along which works will be carried out and schedule the construction works accordingly.

1911. VERIFICATION BY CONTRACTOR

Survey and Dimensional Checking

The Contractor shall be responsible for checking the following prior to carrying out construction work:

i. Confirm the accuracy and suitability of all setting out points, benchmarks, etc., provided to him.

ii. Confirm the alignment and elevations of each proposed pipeline. All elevations shall be related to a single bench mark, which should be checked by the Contractor and agreed with the Engineer.

iii. Confirm the location and elevation of existing pipelines through excavation and backfilling of trial holes

iv. Verify the locations, depths and other details of existing services along the proposed pipeline alignment, through trial holes and liaison with the service providers and informed locals.

v. Confirm extent of existing road reserve and available wayleave;

vi. Confirm proposed distances and lengths;

vii. Confirm location of proposed structures and pipeline routes, including preliminary setting out. Confirm elevations of pipelines at key locations such as crossings of rivers and roads. In particular this shall include sections where pipelines shall cross these locations.

viii. Confirm the level of existing ground prior to any excavation or fill works and agree this level with the Engineer.

ix. The Contractor shall provide the Engineer with drawings and other such documentation confirming all surveys and setting out.

1912. OFFICES, FACILITIES AND EQUIPMENT FOR THE RESIDENT ENGINEER

For Supervision of the Works, offices will be established, either rented or as a separate part of the Contractor's facilities: The Contractor to provide the offices from the date of Commencement of Work. The Offices including their locations shall be to the Resident Engineer's approval.

The Offices shall be of a design and construction approved by the Engineer and shall be constructed of strong, durable and weatherproof materials with walls, ceilings and floors adequately insulated against heat and cold.

The Office shall have a floor area of at least 100 square metres and be provided with equipment and furniture detailed under the following clauses. The Offices shall have burglar proofing to all windows and external doors.

The Contractor shall arrange for the provision of 2 number mobile, smart telephones, including reasonable monthly running costs (e.g. a call and internet data package), with suitable privacy for conversation for the exclusive use of the Resident Engineer and his Staff. Provision shall also be made by the Contractor for all necessary gas, electricity, kerosene, water, light, attendance and stationery required in connection with execution of the Contract.

Security Guards hired from a reputable Security Firm approved by the Engineer shall be provided for day and night security at these Offices. The Office, furniture and equipment shall be insured against fire, theft and natural calamity.

Furniture and Equipment for Resident Engineer's Offices

The office / kitchenette shall be suitably furnished with the following as minimum requirements (all shall revert to the Client at the end of Project):

Stationery	**Quantity**
Writing Desk with 3 lockable drawers	4 Nr
Writing Desk without Locks	1 Nr
High Back Chairs with arm rests	5 Nr
Wooden Conference Table, 3.0m x 1.2m	1 Nr
Wooden Table, 2.4m x 1.2m	1 Nr
Office chairs without arm rests	12 Nr
Visitors Chairs without arm rests	5Nr
Lockable Steel Cupboard (Size 1m x 1.8m x 0.5m deep)	1 Nr
Office paper punch	2 Nr

Stationery	**Quantity**
Pin board 2.4m x 1.2m	3Nr
Whiteboard, 1.2m x 1.2m	1 Nr
Office Tray (3 tier)	4 Nr
Office Stapling Machines	2 Nr
Heavy Duty Stapler	1 Nr
Wooden Filing Cabinets with sliding doors	4 Nr
'Casio' or similar small portable scientific electronic calculator	2 Nr
First Aid kit (for 10 persons) in Metal Box	2 Nr
Potable Fire Extinguisher (5 litres)	2 Nr
Small office scissors	2 Nr
Wastepaper baskets	4 Nr
Electric kettle (capacity 1.8 litres)	1 Nr
Coffee/Tea making facility including crockery for all supervisory staff 5 Nr. and 5 additional guests	1 Nr
Pedastal electric fan, size 400mm	1 Nr
'Sanyo' or equivalent approved Refrigerator (0.3 cu.m. capacity)	1 Nr
Wooden book shelves with lockable glass frontage 2.0m x 1.5m	3 Nr
Desktop – "DELL" OptiPlex 9030, Intel Corei5 (3.0 GHz) Processor, 8GB DDR3 Memory, 500GB SATA HDD, DVD +/-RW, Intel Integrated HD Graphics 2000 card, Dell Optical Scroll USB (2 buttons scroll) Black Mouse, Dell Standard Quietkey USB Black Keyboard, WIFi, Windows 8.1 Pro 64 Bit, 3 Year Warranty, Dell 23 inch Monitor.	2Nr
Laptop – "DELL" Latitude 155000 Series, E5540 Intel Core 6th Gen Intel® Core™ i or Core™ i vPro Processor, 8GB DDR3L, Memory 500GB (5.400Rpm) SATA HDD, 15.6" Antiglare LED Backlit, DVD +/- RW, Integrated Full HD Camera with Microphone, INTEL 4400 HD on Board Graphic Card, Bluetooth, WLAN, Primary 6-cell 65W/HR LI-ION, Windows 8.1 Professional, 3 Years Next Business Day Warranty	2 Nr
Stand-alone ACAD 3D 2016 Civil software including annual maintenance and service fee	3Nr
Printer / Photocopier / Scanning Machine – Nashuatec Model MPC 205/AO 20 Pages per minute, B/W and Colour, A3/A4 Size Paper or approved equivalent	1 Nr
Stand-alone A4 Laser Printer HP or approved equivalent1	1Nr
Petty Cash Box with security lock	1 Nr
Wall Clock	2 Nr
Ibico' or approved equivalent binding machine suitable to bind upto 40mm spirals	1 Nr
Flashlights (battery powered or rechargeable)	2 Nr
Digital Camera, Nikon, Pentax, Panasonic or approved equivalent. Shock and water proof, min 12 megapixels, both optical and digital zoom capabilities, storage capacity of 128 MB	2 Nr

Stationery	Quantity
Smart Phones – Apple I6, 64GB Memory or approved equivalent	3Nr

Provisions and Consumables for the Resident Engineer's Offices

Stationery required **per month** as follows (Stationery to be approved every month by the Resident Engineer before ordering):

Stationery	Quantity per Month
Photocopy paper A4	4 Reams
A3 paper	2 Ream
Biro pens blue/black	½ Doz.
Clutch Pencils	½ Doz.
Box files	6 Nr
Spring Files	6 Nr
Document Wallets	6 Nr
Spirals (various sizes of Reports)	2 Doz.
Embossed (hardback cover)	2 Doz.
Perspex covers	2 Doz.
Cellotape (medium)	1 Nr
Masking tape (medium)	1 Nr
Staples	1 Pac.
Paper clips (various sizes)	1 Pac.
Pencil leads (0.5/0.7)	1 Sets
CD-RW (Pack of 12)	1 Pac.
Highlighters (set of all colours)	1 Sets
A6 hardcover notebooks	2 Nr
Soft Pencil Erasers (Staedtler or equivalent)	2 Nr
Envelopes (all sizes)	3 Doz.
Batteries for flashlights	1 Sets
Black ink cartridge/ toner for the A4/A3 printer	1 Set
Colour cartridges/toner for the A4/A3 printer	1 Set

In addition, for each office, the Contractor to supply clean towels every day, soap, lavatory paper, disinfectant and cleaning materials, coffee/tea, milk, sugar, drinking water, refreshments, etc. These items are to be provided and maintained throughout the Contract Period, adequate for 5 Supervision Staff and 5 additional guests. The List of Provisions and Consumables to be given by the Resident Engineer every month.

The Contractor will also be responsible for the following services for each Office:

i) Payment for all services including water, electricity, sewerage, Telephone and Internet

ii) Guarding of the premises (24 hour security services);

iii) Maintaining insurance against theft of equipment and other materials from the offices;

iv) Service, maintain / repair office equipment and appliances;

Apart from the consumables, the rest of equipment will revert to the Employer at the end of the Contract.

Project Vehicles

The Contractor shall service and maintain the vehicles to be used for supervision of the Contract by the Resident Engineer and his staff.

The Contractor shall ensure that all vehicles are licensed, comprehensively insured at all times, serviced and maintained in good condition to the satisfaction of the Resident Engineer or his authorized representative, so that the Resident Engineer shall at all times have the vehicles available for use in good serviceable condition. In the event of the vehicles being unserviceable for whatsoever reason, the Contractor shall provide alternative vehicles at his own cost of the same model in compliance with the provisions of this clause. The cost for such replacement vehicle to be covered by his rates.

Payments for maintenance shall include for provision of fuels, lubricants and tyres, all regular maintenance, minor and major repairs, including those occasioned by accidental damage from whatever cause arising, and everything else necessary to satisfy fully the requirements of this Clause.

The makes, models and colours of the vehicles shall be approved by the Resident Engineer prior to ordering. Vehicles must be from a manufacturer that has been widely used in Kenya for at least 8 years, with a good distribution of distributors, service centers and spare parts availability.

The Contractor shall, at completion bring the vehicle to the appropriate dealers for testing. The dealers shall recommend to the Engineer's Authorized Representative what repairs in addition to the ordinary service are required to be carried out on the vehicle. The Contractor shall then ensure the necessary service/repairs are done. A certificate of road worthiness and satisfactory mechanical condition to be obtained from the Dealer.

The following will be carried out:

- Inspection by the Government Inspection Unit, if applicable
- Inspection and Valuation by the Automobile Association (AA) of Kenya

The Contractor shall hand over the respective Inspection / Valuation Reports to the Employer together with the vehicles. The vehicles will revert back to the Employer at the end of the Contract.

Drivers

The Contractor shall provide licensed drivers for the exclusive use of the Resident Engineer or his authorized representative. The drivers shall be available at all times during normal working hours and when specifically required by the Resident Engineer or his authorized representative, outside these hours.

The drivers shall have a minimum 10 years of clean driving record and a Certificate of Good Conduct from the Kenya Police. The drivers are to be employed and paid by the Contractor (including all overtime, NSSF, NHIF, etc) but will report directly to the Resident Engineer for day to day instructions. The Resident Engineer will interview, test and approve the drivers prior to their deployment on the Works.

Each driver shall be provided with uniform as follows, as a minimum, to be replenished/replaced as and when necessary as directed by the Resident Engineer. The cost of uniform is deemed to be covered by the Contractor's monthly rate for the drivers.

- 2 Nr good quality Trousers - Navy Blue
- 3 Nr Shirts - Sky Blue
- 2 Nr woollen Sweaters - Navy Blue
- 1 Nr pair Hard Toe Shoes - Black
- 3 Nr Pairs of Socks - Black

General Equipment for the Resident Engineer

The Contractor shall provide for the Engineer, his Representative and assistants any protective clothing and safety equipment necessary for the proper discharge of their duties on the Site.

The Contractor shall provide any necessary protective clothing and safety equipment for the use of authorized visitors to the site including the Employer and his staff and representatives and those of any relevant Authority who have reason to visit the Site.

Survey Equipment

Listed below are the principal items of survey equipment to be made available for use as requested by the Engineer during the whole duration of Project Implementation. All equipment shall be as new and with all necessary carrying containers, manuals, insurances, etc. The Equipment to revert to Contractor at completion of all Works.

Equipment	Quantity
Total Station including tripods, complete with reflectors, poles, brackets and carrying case (Wild or similar)	2 Nr
Automatic Level (Wild or Similar) with legs and metric staff, complete with carrying case	2 Nr
Metric extending levelling staffs with vertical bubble	2 Nr
30m (enamelled or otherwise protected) steel bands	2 Nr
3 metre ranging rods	30 Nr
Survey umbrellas with stand	6 Nr
Work boots	8 sets
Rain Gear (trousers and jacket type, complete with rain hat)	8 sets

Equipment	Quantity
Hard hats	12 sets
5 metre retractable pocket steel tapes	8 Nr
30 metre metal tapes	4Nr
100 metre metal tapes	3Nr
Builders spirit levels 1000mm long	4 Nr
Hammers 3 kg each	4 Nr

The Contractor shall also supply pegs, crayons, spray paint, nails and all other items required for setting out and measuring the work.

The Contractor shall be responsible for maintaining the survey and field equipment throughout the Contract Period, including replacement of items damaged during the normal course of the Works.

The Contractor shall provide all such labour and assistance as may be required by the Engineer for checking the Contractor's setting out and/or survey.

Accommodation

The Contractor to make provision for accommodation for the Resident Engineer (RE), Assistant Resident Engineer (ARE) and Inspectors of Works. The furnished rented houses shall be to the approval of the Resident Engineer and shall comply with all his requirements. All costs in connection with the rental of house, supply, consumption and maintenance of water supply, electrical power, house help, etc., shall be borne by the Contractor. Provisions of full time security guards shall be made for the houses for day and night security. The provision for this is made under the relevant item in Bill No. 1 – Preliminaries & General.

1913. OFFICE FOR CONTRACTOR

The Contractor shall have an office on the Sites to be approved by the Engineer and which shall be open and attended to at all hours during which work is in progress.

1914. COMMUNITY LIAISON

Due to the high population density in the Project Areas as well as the large number of affected people and the difficulties associated with working in the high density low income areas, the Contractor shall have a qualified Community Liaison Team which should be based on Site permanently during the Construction Period. The Community Liaison Officers will be vetted and approved by the Resident Engineer and they shall work closely with the Client's Community Liaison Team.

1915. SUMMARY OF DOCUMENTS TO BE SUBMITTED

The schedule below gives an overview of the technical and planning documents that shall be submitted by the Contractor for the approval of the Engineer in accordance with the contract. This list must be cross-checked and confirmed by the Contractor and is for guidance purposes only, i.e. it is not exhaustive!

In general the Contractor must plan the timing of the submission of all documents so that the Engineer has sufficient time for checking and approving documents prior to the Contractor commencing any related activities.

Item	Document	Description	Copies	Language	Timing
A	**General**				
A1	Programme	Detailed construction program	5 hard 1 digital	English, and local language	Order to commence +28
A2	Manufacture & delivery of plant & equipment	Including brief description of basic equipment parameters, country of origin, quantity, unit and total price. Including Conformity Certificates!	2 hard 1 digital	English, and local language	Relevant approvals + 28 days
A3	Cash Flow	Detailed cash flow	3 hard 1 digital	English, and local language	Contract Agreement + 28
A4	Schedule of submittals		2 hard 1 digital	English, and local language	CD + 14 days
A5	QA Plan		2 hard 1 digital	English and local language	CD + 28 days
A6	Project Specific Environmental and Social Management Plan (ESMP)		2 hard 1 digital	English and local language	CD + 28 days
A7	Project Specific Health and Safety Management Plan (HSMP)		2 hard 1 digital	English and local language	CD + 28 days
A8	Traffic Management Plan		2 hard 1 digital	English and local language	CD + 28 days
A9	Preservation of Evidence Site Condition Survey		3 hard 1 digital	English and local language	To suit construction programme
B	**Drawings, records and documents**				
B 1	Structural / Civil / Shop Drawings	Construction drawings and details	3 hard 1 digital	English and local language	To suit construction programme

Item	Document	Description	Copies	Language	Timing
B 2	As-Built / Record Drawings		4 hard 1 digital	English, and local language	Three weeks before the issue of the "Take-over Certificate"
C	**Reporting**				
C1	Site Diary		2 hard 1 digital	English, and local language	Daily, maximum of 2 days after day
C2	Monthly Progress Reports		3 hard 1 digital	English, and local language	monthly
C3	Record of Contractors Personnel & Equip.		1 hard 1 digital	English, and local language	monthly
C4	Method Statements	Description of construction and testing procedures	2 hard 1 digital	English, and local language	At least 14 days before its intended commencement date for the respective activity of work
C5	Inspection and testing schedule	Including methods of testing of materials, phases of construction and equipment	2 hard 1 digital	English, and local language	In accordance with Contractors programme
C6	Report on Tests on Completion	As specified	4 hard 1 digital	English, and local language	As pre- condition for TOC

Abbreviations:
CD Commencement Date
TOC Taking Over Certificate
QA Quality Assurance

The costs for the preparation of all documents, such as for keeping records, reporting, shop and construction drawings, as-built drawings, manuals etc. shall be included in the unit rates and Contract price.

Schedule of Submittals

Latest 14 days from CD the Contractor shall submit a general schedule of contractually required documents for submission to the Engineer.

The schedule shall be in the form of a list with all documents required in the Employers Requirements and General and Particular Conditions of Contract! Each item shall state the reference to the Clause in the Contract and the required contractual submission date.

This list shall summarize in general the contractually required submittals.

1916. PERFORMANCE TESTING

The Contractor shall perform all necessary tests to demonstrate compliance of the Works with the specifications, performance criteria and guarantees. During the tests the Contractor shall demonstrate to the satisfaction of the Engineer that:

- The Works are capable of achieving the specified Performance Standards;
- The Works comply fully with the Specifications.

The tests shall include, but not be limited to:

- Inspection and testing at the manufacturers' premises (Factory tests).
- Inspection and testing during construction
- Tests on Completion (Commissioning and Performance Tests)

A minimum of 21 days' notice in writing shall be given to the Engineer and the Employer prior to carrying out any inspection or testing.

Procedures and work processes for the recording of test results shall be set out in the Contractor's Quality Plan and approved by the Engineer.

Where specialized test equipment is supplied, the Contractor shall provide the associated test sheets, which shall be submitted to the Engineer for review prior to the tests being carried out.
All tests specified must include the provision of the required test equipment and shall be carried out at the risk and expense of the Contractor.

The Contractors rates are deemed to cover all tests required, except where separate additional items for testing are included in the BoQ.

Inspection and Testing at the Contractor's or Manufacturers' Premises

All major items of plant, including but not limited to pumps, control panels etc., shall be subject to testing by the Contractor and inspection by the Engineer, if so required, before dispatch from the manufacturers' premises, with all tests arranged to represent the working conditions as closely as possible.

20.WATER PIPELINES

2001. GENERAL

This Specification applies in particular to Water Supply Pipework. Pipes, Valves and Fittings shall comply with the relevant International and/or National Specifications as stated hereinafter.

In general, the recommendations contained in EN 1295 Part 1: 8.1.1.2 (with regards to pipe design), and BS 8010, EN 1610 and BSCP 2010 or their equal (with regards to general pipe work and its installation) shall be followed in so far as they are relevant to the prevailing conditions. For design recommendations not covered by EN 1295, reference should be made to BS 534, EN 10224, EN 10311 and AWWA M11 for Steel Pipes, EN 545 – 2010 for Ductile Iron Pipes; BS 2782, BS EN 1452, BSCP 312, EN 921 and for uPVC; and BS3284 and EN 12201 for HDPE (PE100) Pipes.

At all times latest editions and updated standards and procedures for design and installation shall be used and adopted. In the same context the Contractor may provide, with the approval of the Engineer, superior materials using other standards not listed here, provided they can demonstrate this to be the case through tests, examples and guarantee certifications.

The Contractor shall be wary of the worst case scenarios making the installed pipes unsuitable and these can be caused by such things as unsuitable soils, shallow depths, bedding types and extraordinary traffic loads among other things and the Contractor shall inform the Engineer when they occur.

As a general guidance, the Pipes proposed for the Contract shall conform to the following International and National Standards unless a superior quality is demonstrated.

2002. STANDARDS FOR PIPELINES

Pipeline General	EN 1295 Section 1.81.12 - Structural Design of Buried Pipelines, saving that where the Specification is silent on any pertinent matter, then the alternative relevant part of the SRN (e.g. AWWA) indicated shall be complied with. BS 8010 British Standard Code of Practice for Pipelines Part 2 Pipeline on Land: Design, construction and installation Section 2.1 1987 - Ductile Iron BSCP 2010- 2- Design and Construction of Steel Pipeline Inland
Steel Pipes & Fittings	BS EN 10224:2002 or AWWA C200 Standard Steel Grades, ISO 559 (higher grades may be specified or allowed only with the written authorisation of the Engineer). Wall thickness ISO 559 as a minimum, unless otherwise indicated or specifically authorized following a design certified by the manufacturer. Flanges BS EN 1092

	Coating: Triple layer polythene coating (3LPE) to EN 10288 and DIN 30675 Part 1 for Type III soil, film thickness EN 10288 Lined with cement mortar as per EN 10298 up to and including DN600, for bigger Fusion Bonded Epoxy to EN 10339 or DIN 2614
Ductile Iron Pipes & Fittings	Pipes and Joints BS EN 545, 2010 Flanges BS EN 1092 Coating and Lining to DIN 30674 and DIN 30675 for Type III soil
HDPE Pipes & Fittings	DIN 8074 Polyethylene (PE) - Pipes DIN EN 12201 Plastics piping systems for water supply, and for drainage and sewerage under pressure - Polyethylene BS ISO 4427-1:2007: Plastics piping systems. Polyethylene (PE) pipes and fittings for water supply. General ISO 12176 (butt welding and electrofusion), ISO 21307 and DVS 2207-1 (butt welding), ISO 14236 (mechanical joints), Main Lines: HD-PE 100, SDR 17, PN 10 Consumer Connections: HD-PE 80, SDR 11, PN 10 Fittings shall in general be Steel or Ductile Iron whilst electro-fusion jointed bends and tees shall be allowed providing these are not formed by bending straight pipe below the minimum radius specified.
uPVC pipes	BS EN 1452 Fittings shall in general be Steel or Ductile Iron. Injection moulded uPVC bends and tees shall be allowed if designed to sustain equivalent pipeline pressure

2003. CERTIFICATE AND SAMPLES FROM PIPE MANUFACTURERS

Unless not required by the Engineer, for all pipes proposed to be supplied samples shall be provided by the Contractor. If accepted, the samples shall be used for the purpose of comparison with all components of a similar nature delivered subsequently. Any subsequent goods supplied that do not meet the standards of the sample shall be liable to rejection with all consequences to the cost of the Contractor.

The Contractor shall within 42 days of award, supply to the Engineer a signed certificate from the pipe manufacturer(s) stating that the pipes and fittings comply in all respects with the provisions of these Specification and the indicated National or International Standards, and that they shall conform to the required standards for all raw materials, processes, quality control, manufacturing, and for fully manufactured products including where appropriate, the handling to shipment. The pipe and fittings manufacturer's key personnel shall have at least three (3) years

relevant manufacturing experience especially in regards to plant management, quality control/ quality assurance, application of the coating and lining systems offered in the bid. The Contractor shall have submitted reasonable documentary evidence with its bid to support statements made in the bid documents in this regard. The manufacturer shall also state that they have the ability to carry out the necessary tests during the manufacturing process and tests on the finished products as required by the respective standards.

The Contractor shall also submit a copy of the Pipe / Valve Manufacturer's Quality Assurance (QA) System complying with ISO 9000/9001/9002, together with sufficient information from the manufacturer's Quality Assurance Plan (in English) to enable the Engineer and Employer to understand the levels of performance offered.

The Contractor shall furnish the Engineer with a manufacturer's certificate in respect of every consignment of the pipeline materials, confirming that all the items of the consignment comply in all respects with the requirement of the specified standards and of this specification. The original and one copy of such manufacturer's certificate shall be delivered to the Engineer prior to shipment in the case of imported pipes and prior to dispatch from the factory in the case of local manufacture.

The original and one copy of such manufacturer's certificate shall be delivered to the Engineer prior to shipment.

2004. INSPECTION AND TESTING DURING MANUFACTURE

During manufacture and before dispatch of pipes and fittings from the place of manufacture, the Contractor shall allow for inspection by the Engineer and the Employer of all the manufacturing process and tests on raw materials and finished products. The inspection will include attendance for pressure and material tests, execution of dimensional checks and inspection of the workmanship and standard of manufacture with scrutiny or evidence of the materials used in the fabrication of the Pipeline Materials.

The Engineer and the Employer's representative shall be allowed full access to all areas at the place of manufacture or elsewhere where testing, furnishing or preparation of materials for the performance and testing of work under this Specification is taking place.

The Contractor shall furnish the Engineer with reasonable facilities and space (without charge) for the inspection, testing and obtaining of such information as he desires respecting the character of material in use and the progress and manner of the work.

The Contractor shall arrange for such testing at his cost as may be required to be carried out at the place of manufacture according to this Specification. If there are no facilities at the place of manufacture for making the prescribed tests the Contractor shall bear the cost of carrying out the tests elsewhere or avail third party to carry out such tests.

The Contractor shall supply test certificates and shall furnish and prepare the necessary test pieces and samples and shall supply and provide all test rigs, equipment appliances, labour and any other facility required for inspection and testing.

In the duration of the Contract, the Contractor shall propose a schedule for four inspection visits to the pipe manufacturers' yard by three representatives of the Employer and the Engineer and Engineer's Representative during the manufacturing and pre-shipment stages.

2005. THIRD PARTY INSPECTION OF MANUFACTURERS WITH ISO 9001/9002 ACCREDITATION

As quality assurance is of utmost importance to ensure extended asset lives, all manufacturers of pipes and fillings shall have facilities to conform to international standards and also carry out tests related to raw material testing (confirmation of Steel Grades, etc.) manufacturing process, finished products and handling to shipment.

In the event during inspections and tests carried out in presence of the Employer and Engineers show inadequacies in the manufacturing process resulting in non-conformance finished products to an unacceptable level, the Employer will deploy his agent or third party inspector to carry out independent third party Inspection.

In such an event the supply and incorporation of materials from such source shall be stopped immediately until further notice and the Contractor shall instead provide materials from another approved source. The Contractor shall be required to replace at his cost all the rejected materials including the cost of this inspection in the event such third party inspection reveal non-conformance in manufacturing and quality standards. The inspectors shall be provided with full access to carry out third party inspection including the use of the in-house testing processes.

2006. ACCEPTANCE OF PIPES, VALVES AND FITTINGS

Only pipes, valves and fittings that are manufactured using acceptable materials, tested and delivered by firms which had been proven at the time of Bid to be listed under the ISO Standards hereinabove provided for, shall be accepted as conforming to the Contract. The Client reserves the right to accept the proposed materials in the Bid. The Client may request for Third Party Inspection of specific materials prior to approval. The cost of these Third Party Inspections will be borne by the Contractor and the Client reserves the right to accept or reject findings of the Third Party Inspection. Any other pipes, valves and fittings, other than those approved by the Client, shall be liable for rejection at the Contractor's risk, cost and responsibility.

Compliance with the provision of this Clause shall be separate and additional to the Contractor's compliance with the requirements of Kenyan Customs Authorities for pre- or post-shipment inspection of imports into Kenya. The costs for such third party inspection shall also be fully borne by the Contractor.

For ferrous pipes, emphasis is placed on corrosion protection and therefore no compromise will be accepted in pipe thicknesses, lining and coating, so that the asset life is extended beyond 50 years. Unlike plastic pipes, ferrous pipes can withstand external pressure and therefore the bedding requirements are less stringent provided however they do not negatively affect the coating.

Except where otherwise specifically indicated, all ferrous pipes shall be barrier coated.

It is important therefore for the Contractor to ensure that their ferrous pipe manufacturers are able to supply pipes and fittings with the specified lining and coating materials and that the manufacturing unit from where pipes are manufactured have at least five years of successful

track record in supplying pipes with the required lining and coating materials. The manufacturer shall also be able to demonstrate that the lining and coating materials and application provided withstand all the necessary tests as detailed in this specification.

2007. DETERMINATION OF NATIVE SOIL CORROSION CHARACTERISTICS

The Employer has carried out some random trial pits along the pipe alignment. Generally the soils in the area are moderate and non-corrosive. However, the Contractor has a duty to warn the Engineer if there are any areas of concern, and in which case the Engineer may instruct the Contractor to carry out further investigation and confirmation of soil corrosion characteristics so as to ensure optimum life expectancy of the pipeline. Such additional investigations should be primarily targeted at swampy areas located along the pipeline route.

If so instructed, the Contractor shall determine the native soil corrosion characteristics in accordance with DIN 50929 and DIN 50929-3 to confirm whether the specified pipe coatings provide adequate protection in keeping with an expected life of 50 years.

2008. TRANSPORTATION, HANDLING AND STORAGE

The Contractor shall further have described in his Bid in full detail the method(s) of offloading for imported items or on-loading for locally manufactured ex-works items, the methods of road/rail transportation and of site off-loading including the lifting methods intended. He shall further have described in his Bid in full detail the method(s) of stacking and storage. His Bid shall also be deemed to have included for the transportation as described and for the provision of all the necessary facilities for off- loading at the storage sites, and for proper stacking and storage.

2009. EXCAVATION OF PIPE TRENCHES

Except where otherwise indicated on the drawings or directed by the Engineer, it is intended that the trench shall be excavated to such a depth as will allow of a minimum cover over the top of the barrel of the pipe when laid as follows:

- Under roads and trafficked areas – 1.2m
- Road Reserves – 0.9m
- Fields and open areas – 0.6m

For the purpose of measurement, the width of trench shall be taken as the nominated width for the particular size of the pipe, irrespective of the width of trench the Contractor may choose to excavate.

Nominated trench width for:

OD63-90	0.5m
OD110	0.6
OD160	0.6
OD225	0.7
OD355	0.8
DN400	0.9
DN500	1.0
DN600	1.2

DN800	1.4
DN1000	1.6

For two or more pipes in the same trench the nominated width shall be the distance between the centres of the outer pipes plus the internal radii of the outer pipes plus 400mm.

When any excavation has been taken out and trimmed to the levels and dimensions shown on the drawings or as directed by the Engineer, the Engineer shall be informed accordingly so that he may inspect the completed trench and no excavation shall be filled in or covered with concrete until it has been so inspected and the Contractor has been authorized to proceed with the work.

The Contractors rates in the BoQ shall include all works and items necessary for pipelaying, including keeping all excavations dry, and all bailing and pumping, timbering, shoring and supporting of sides that may be required, and any refilling, ramming and disposal of surplus materials necessary in carrying out the excavations and backfilling of trenches shall be taken to provide a solid and even bed for the pipes.

The pipe trench shall be kept clear of water at all times and the Contractor should include the cost of this in his rates and consider this in his planning, e.g. due to the rainy seasons or work alongside water bodies or areas prone to flooding.

During excavation, the Contractor shall ensure that all material suitable for re-use is kept separate and set aside and protected as necessary to prevent loss or deterioration. Sorting or sieving of material may be required. The cost of this must be included in his rates. Materials forming the surface and foundations of roads shall when excavated and if required for further use, be carefully separated. Paving slabs, bricks and similar surfaces shall be carefully removed and stacked for reuse, or as otherwise instructed by the Engineer.

For all excavation in rock the Contractor must obtain the prior agreement of the amounts with the Engineer, otherwise any claims for excavation in rock will not be considered!

2009.1. Deep excavations

The terrain in most sections of the proposed pipeline route is gently sloping and normal excavation depths will be adequate. However, a few localized high points exist along the pipeline route necessitating deep excavations of up to 4 m.

In addition, pipeline sections at road crossings and under- the river crossing require adequate ground cover resulting to deep excavations. However, it is only these few sections of the pipeline that will require deep excavations.

The Contractor should allow for these deep excavations in his planning.

2010. PIPE INSTALLATION

2010.1. Assistance by Pipe Manufacturer

The Contractor shall utilise the technical services of the pipe manufacturer, unless he already has in his proposed site team persons of appropriate competence with proven experience in the laying of pipes of the type and magnitude to be provided. This shall cover the laying and jointing, external pipe protection work, trench backfilling and testing periods, etc, all in accordance with the Contract so as to ensure the maximum life span for the works. The cost of the above shall be deemed to have been included by the Contractor in his Bid.

2010.2. Working Width

Prior to excavation, the Contractor shall agree with the Engineer the overall width required for pipe installation. Clearance shall be limited to this area. However in areas of limited access the Engineer reserves the right to restrict this width and the Contractor shall not claim for additional monies due to inconvenience associated with such limitations, e.g. for double handling of materials, supporting of trench sides, movement of pipes into position, etc.

2010.3. Location of Underground Services, etc.

The Contractor shall locate existing services prior to excavation. Notwithstanding this obligation and should damage occur, it will be the Contractors further obligation at his own cost to urgently liaise with the utility organization concerned and to bear the full cost of the repair or replacement of the damaged article to the entire satisfaction of the Utility concerned.

For all services a minimum distance of 0.3m should be maintained between the newly laid pipes and existing services.

2011. REINSTATEMENT OF SURFACES

All surfaces of roads, fields, paths, gardens, verges, etc. whether public or private which are affected by the operations of the Contractor shall fully restored to a condition as prior to the works, at a minimum.

Reinstatement must be carried out as per the Specifications, or as per the requirements of the relevant Road Authority, which the Contractor should make himself aware prior to bidding, whichever is the more stringent.

Following the reinstatement of roads, the Contractor will be responsible for any tests of the material used and tests of the quality of the road reinstatement works as per the requirements of the owners (Public Authority) of the road.

2012. STEEL PIPES AND FITTINGS - MATERIALS AND STANDARDS

Steel Pipes and Fittings shall generally comply with EN 10224:2002, ISO 559, AWWA C200, M11 and other International standards that specify superior pipe thickness and lining / coating materials. All latest and updated international standards pertaining to Steel Pipes and Fittings shall apply. All steel pipes shall be joined by welding, no other joints or couplings will be accepted, except where otherwise shown on the drawings or in the BoQ.

2012.1. Standard Pipes and Fittings

Specifically Steel Pipes shall dimensionally conform to BS 534 and EN 10224, and in terms of materials, properties and tests to BS 3600 and BS 3601 and EN 10220, EN 10216 and EN 10217, or AWWA C200. Pipe lengths shall be as per manufacturer's recommendation and adjusted as necessary to suit transport and site conditions, especially in areas with steep gradients and difficult access. Fittings shall in general conform dimensionally to BS 534, AWWA C208-01 and AWWA M11, however where specifically required the lengths of straight barrel sections may exceed or be less than standard dimensions. They shall be manufactured from pipes that have been manufactured to BS 534, EN 10224, BS 3660, EN 10220, EN 10216-1, or EN 10217-1, and successfully passed all mechanical, dimensional visual, pressure and non-destructive testing. All new welds made during the fabrication of the fittings shall be subject to non-destructive testing using either radiological, ultrasonic or dye penetrants dependent upon the geometry of the weld.

Where necessary, fittings shall be reinforced in accordance with AWWA C208-1 and AWWA M11. **The cost of reinforcement of all fittings should be included in rates for the respective fittings at time of bidding.**

Fittings may be reinforced in various ways for resistance to internal pressure. Typical fitting reinforcements are collars, wrappers and crotch plates. The design stress in the reinforcement should not be greater than the hoop stress used in the design of the pipe.

The type of reinforcement can be determined by the magnitude of the pressure-diameter value (PDV) and the ratio of the branch diameter to the main pipe diameter d/D.

The pressure-diameter value is calculated as:

$$\text{PDV} = \frac{Pd^2}{D \sin^2 \Delta}$$

Where:

P = design pressure (psi)
d = branch outside diameter (in.)
D = main pipe outside diameter (in.)
Δ = branch diameter angle of deflection

For PDV values greater than 6000, the outlet reinforcement should consist of a crotch plate. For PDV values less than 6000, the outlet reinforcement may be either a wrapper or collar, depending on the ratio of the outlet diameter to the main pipe diameter d/D. For a d/D ratio greater than 0.7, a wrapper plate should be used; for a d/D ratio less than 0.7, either a collar or a wrapper plate may be used. The ratio d/D does not include the sin Δ as in the PDV determination because the controlling factor is the circumferential dimensions. Wrappers may be substituted for collars, and crotch plates may be substituted for wrappers or collars.

The out of roundness at a plane perpendicular to the pipe axis at any point along the pipeline length shall not exceed 4% of the minimum as laid inside diameter (i.e. + 2% of the nominal internal diameter) after completion of the backfilling and with atmospheric pressure inside the

pipe. Out of roundness being measured is the difference between the minimum and maximum inside diameter of the pipe at a point.

In case the above quality control on roundness of pipes and fittings is not achieved, the Contractor will provide remediation measures to all pipes and fittings at his own cost and to the approval of the Engineer.

Fitting ends for use with flexible couplings shall be true ended with the ends appropriately prepared for the type of coupling required.

Joints for site welding shall comprise bevelled edges to BS 534 or EN 10311 such that the lining shall be undamaged during the welding.

Any horizontal / vertical deflection below 7^0 will require mitre cutting of the plain ended pipes (one end or both ends depending on angle of deflection required), before mating ends and carrying out field butt welding at the joints. The cost of mitre cuttings is deemed to be included in the Contractor's rates for pipelaying.

All bolts shall be hot dipped zinc coated and those for bolted sleeve couplings further protected with a topcoat of aluminium pigmented organic epoxy to their respective standards, unless otherwise indicated on the drawings or in the Bills of Quantity.

The Contractor shall demonstrate that the thickness and steel grade provided in accordance with ISO 559 gives a thickness adequate for the pressure calculated in accordance with EN 1295. The thickness calculation shall take into consideration the following: the operating pressure, test pressures, pressure transients or surges if applicable, external pressures, steel pipe strength characteristics, temperature, soil condition, trench width and depth and appropriate traffic load.

2012.2. Welded Pipelines

All steel pipes and specials supplied under the Contract larger than DN600 shall be joined by field welding and so shall be supplied with ends bevelled for welding. Field welding of joints shall conform to BS EN 288-9:1999 or API 1104.

All field welding shall only be done by welders who satisfy the requirements of BS EN 287-1:1992 or API 1104 and who have been tested and approved by an Independent Testing Authority. Welders must also be certified as per the Kenyan requirements. Each welder deployed shall at intervals of not more than 6 months undergo similar approved retesting and only those who pass such retesting will be allowed to continue to undertake the in-situ welding works. Sufficient records shall be kept by the Contractor to ensure that all field welds can be subsequently identified with the welder concerned.

Before any welding of pipeline materials commences, the qualification of welders shall have been approved, all detailed welding procedure method statements, with weld diagrams required for their completion, shall have been submitted and approved, and the welding procedure qualification tests shall have been successfully concluded, all in accordance with the relevant Specifications.

Wherever it is necessary to undertake in-situ welding of steel fittings and flanges the work shall be undertaken under cover, temporary or otherwise. No welding shall be carried out during rain or high wind or under dusty conditions unless the welder, the weld area and the weld are adequately protected and sheltered. Outside of buildings, the cost of providing such cover shall be deemed included in the Contractors rates.

Welding procedures used shall comply with ISO 15607 and EN 288-9, using a manual metal arc process (vertical-down technique and cellulose electrode).

Only approved welding rods which have been kept dry and uncontaminated shall be used. Welding rods shall be of a grade and quality such that the chemical composition of weld metal and parent metal is similar. All welding rods shall be approved prior to ordering. Inspection of storage areas, storage records for issuance of welding rods and confirmation of their use will be available to the Engineer as and when required. Any contamination of supplies of such materials and use of unapproved welding rods will result in rejection of pipeline section and its replacement at Contractor's own cost.

Before proceeding to welding of joints, pipe ends shall be completely circular and properly mated up by means of backing rings/clamps. At least 4 tack welds equally spaced around the pipe perimeter shall be applied to maintain the root gap and position of the pipe for completion of welding. A protective plastic or rubber sheet shall furthermore be placed over the coating adjacent to the joints to protect the same from damage caused by welding spatter.

Root welds shall thereafter be carried out followed by successive filler passes, and capper passes, all in accordance with the approved welding procedure. Wherever it is possible to have entry into a pipe, inside welds shall be applied first. The inner weld bead shall not extend more than 1mm into the bore of a pipe or special.

Horizontal weld seams or spiral weld seams at pipe ends shall be placed near the horizontal diameter of the pipe or special and shall be staggered so that the circumferential distance between longitudinal or spiral welds intersecting the same circumference is greater than 90mm and not more than 130mm apart.

Defects caused by stray welding arc flashes, weld spatter etc. shall be removed by grinding provided that pipe wall thickness are not reduced to less than the specified minimum thickness, otherwise the portion containing the defect shall be cut out and repaired.

During welding of pipes, the pipe shall be protected with organic linings, mats of thick rubber felt or other suitable material which shall be placed along the pipe invert to protect the pipe lining for the full distance from the point of access up to the point of weld or weld Inspection. The mats shall be of sufficient width and shall cover a sufficiently wide area of pipe invert to protect the lining against damage due to access by staff, equipment, inspectors or fall out from arc weld. Workmen shall wear soft, rubber-soled shoes before entering lined pipes.

Care shall be taken not to stroke arcs on epoxy-lined areas and protective tapes, if any, at ends of epoxy lined pipes shall only be removed immediately prior to welding.

Pipes may be welded together alongside the edge of the trench. For factory lined and coated pipes, the maximum length so welded together shall be such that:

i) the pipe can be subsequently stored, lifted or handled without damage to lining
ii) the out of roundness at a plane perpendicular to the pipe axis at any point along the pipe length during storage, lifting or handling does not exceed 4% of the minimum inside diameter (out of roundness being measured as the difference between the minimum and maximum inside diameter of the plane at the point);
iii) safe and easy access to internal tie-in welds are assured for staff and Inspectorate with equipment;
iv) the maximum length does not exceed 36m

Snaking into the trench of butt-welded sections of pipe shall be permissible for bare steel pipes, subject to approval by the Engineer of a complete and comprehensive method statement submitted by the Contractor and provided that the out of roundness as defined and measured above during any stage of the snaking operation, does not exceed 4% of minimum internal diameter.

The linings and coatings of pre-lined and coated pipes jointed together outside the trench shall be made good at these joints outside the trench.

All (100%) field welding joints shall be subjected to non-destructive testing using either radiological, ultrasonic or dye-penetrants depending on the geometry of the weld. Contract rates for supply and installation of butt-welded steel pipes and fittings shall be deemed to cover the specified non-destructive testing as specified in BS EN 288-9: 1999 or API 1104. The testing shall be carried out by an Approved / Licenced Specialist Contractors approved by the Engineer. The records of all testing shall be maintained as specified. All testing and retesting will be deemed to be covered in the Contractors rates.

Weld defects shall include cracks, lack of complete penetration, lack of complete fusion, and undercutting or reduction in pipe wall thickness adjacent to a weld exceeding 0.5 mm in depth. Slag inclusions and gas pockets or voids considered to be minor imperfections may be accepted if the maximum size and distributions does not exceed the limits.

As a minimum control on weld quality the Contractor shall be required to take and submit radiographs for 3% of all welded length. Where radiographic examination reveals defects in the welds the Engineer will either reject the length of pipe containing such defects or will permit the Contractor to carry out repairs and to submit radiographs of such repairs for clearance. Lengths of pipe containing defects in welds after repair will be liable to be rejected.

If defects in welds are found in a length of pipe or specials, the welds of the pipes and specials immediately before and after the defective pipe or specials in the production line shall be radiographed until the Engineer is satisfied that all the welds are considered satisfactory.

2012.3. Pipelines with Flexible Couplings

Steel pipes with flexible couplings are permitted from DN 65 to DN 600, outside chambers. They may be plain ended, suitable for jointing with flexible couplings and flange adapters, or grooved for thrust-transmitting self- sealing joints, or with socket and spigot with rubber gaskets as described herein. Steel pipes from DN 650 upwards shall be joined by field welding and so shall be supplied with ends bevelled for welding. Steel pipes within chambers shall be suitable for jointing as shown on Bid Drawings.

Flexible joints shall be bolted sleeve couplings to BS 534 and EN 10311 or flexible grooved joints, with a tapping boss to BSCP 2010-2 or AWWA C606, and of approved pattern. Flexible couplings shall be coated with fusion bonded epoxy layer 350 microns thick. Flexible couplings shall be of a mechanical type coupling consisting of a centre sleeve, two end ring flanges, two wedge shaped sealing rings of Nitrile rubber, and with galvanised nuts and bolts. The main components shall be made from hot rolled steel for larger diameters and malleable cast iron to EN 1562 or ductile iron for smaller diameters. If specifically called for, couplings shall be provided with a suitably sized screw plugged hole in the sleeve to allow for the introduction of molten bitumen for additional internal protection. The manufacturer shall then include the necessary removable internal backing-up rings of rubber composition and shall further include for all materials for in-situ jointing and protecting both for remedial works and for internal and external protection at such Joints. After jointing, the exposed part of the bolt shall be provided with a tight fitting polythene protection cap unless capped nuts are used.

Joints by flexible couplings shall be made only in their final laid position. Before assembling the joint, care shall be taken to ensure that pipe ends are clean and free from burrs and ridges. Such burrs and ridges shall be removed if present and linings and/or coatings made good where damaged. Pipe ends shall be mated carefully before joints are made. Pipe ends shall be concentric and perfectly lined up and the coupling shall not be relied upon to line up or to support the pipe.

Joints shall be made and couplings assembled to the manufacturer's instructions. Bolts shall be placed with bolt heads alternately pointing in opposite directions.

Half of the coupling bolts, equally spaced, shall first be partially tightened up in a regular sequence, using a short spanner. The remaining bolts shall then be similarly tightened. After checking the coupling alignment, the bolts shall then be finally tightened evenly and in a regular sequence by means of a torque wrench.

Where couplings without central registers are used, precautions shall be taken to ensure that the pipe ends are apart by the same distance as if a coupling with central register had been used and the couplings shall be carefully centred over the pipe ends.

Where a manufacturer opts for steel pipes with socket and spigot joints, or such joints are specifically called for, such joints shall in general conform to BSCP 2010-2, AWWA C200.97 or EN 10224, and the manufacturer shall submit calculations that the natural sag under 1.5 m of soil load with 90% compaction and a parked vehicle (wheel load and overload as defined above) will not exceed 2.0% on the spigot end of the pipe with the coating and lining as specified. The socket and spigot assembly shall be capable of withstanding a works test pressure of not less than 1.5 times the nominal pressure of the pipeline unless indicated otherwise on the Bid Drawings or in the Schedule of Prices and Unit Rates. Sockets shall be produced integral with the pipe and be hot formed. Rubber gaskets shall conform to EN 681. Unless a high pressure seal, they shall have a front lip for dirt removal and a back lip for pressure sealing. Unless otherwise indicated, the internal laces of the sockets shall be coated in fusion bonded or liquid epoxy. A tight clearance shall be maintained between socket and spigot and should be in the range 1.6 mm +/- 0.8 mm.

2012.4. Flanged Joints

Where specifically called for or deemed appropriate, flanged joints shall be utilised. They shall conform to EN 1092, drilled to NP 10 except where otherwise indicated, with gaskets

made of reinforced elastomer rubber to EN 1514 and of minimum thickness of 3 mm. They shall be stored in accordance with EN 2230.

Bolts for flanged joints shall conform to ISO 4014-1 threaded to BS 3643, nuts to EN 24032 or SO 4032 and washers to BS 4320. Bolts, nuts and washers shall be protected to ISO 4032 or EN 24032 for above ground installation and to BS 3382-7 for below ground installation and in chambers. Nuts for use with self-sealing joints for steel pipes shall be as described under the section for service connections. Exposed threads of all bolts shall be filled with a light plastic cap after flange assembly.

Flanges shall be truly parallel with all bolts evenly firm before being finally drawn up with torque wrenches to water tightness. Taper gauges shall be used to check that there is a uniform gap before and after final tightening up of bolts. Bolts shall be tightened in an approved sequence with bolts equally spaced and at opposite ends tightened equally first.

The Contractor shall ensure that the correct jointing materials, i.e. gaskets, bolts and nuts are available when required. Only correct diameter and lengths of bolts and studs shall be used. Flat washers shall be used under all nuts. The length of bolts and studs shall be such that at least two threads protrude from the nut when fully tightened. The threads of bolts, studs and nuts shall be thoroughly cleaned and then coated with a graphite/grease compound immediately prior to assembly.

Flange faces shall be given two coats of an approved bituminous primer before mating. Flanged fittings shall be so installed that there are no stresses induced into the pipework, specials or fittings by forcing Ill-fitting units into position or by bolting up flanges with faces not uniformly in contact with their gaskets over their whole faces.

2012.5. Maintenance of Cleanliness During Laying

The interior of pipes shall be perfectly clean before being laid and the Engineer may instruct pipe interiors to be cleaned or washed before the pipes are lowered into the trench. All brushes, trowels, welding rod stumps, pieces of mortar, dust and all foreign matter shall be removed from pipes immediately after laying. Once a section of pipeline has been cleaned, it shall be sealed off and shall not be entered again unless permitted by the Engineer in writing.

The Contractor shall at his own expense make good any damage to valves and fitting or clogging of off-takes or malfunctioning of fittings which result from his failure to keep the pipeline in a thoroughly clean condition.

2012.6. Internal and External Works Protection

a. Pipe Coating

All coatings shall conform to DIN 30675 Part I for Type III soil or equal and coating thickness shall conform to DIN 30670 or equal unless a less rigorous type soil is indicated.

All coatings shall be of the factory applied barrier type.

The preferred coating for buried steel pipes shall be factory applied external protection with triple layer polythene coating (3LPE) to EN 10288 and DIN 30675 Part 1 for Type III soil comprising

triple wrap system of fusion bonded or sprayed epoxy primer, an intermediate polymer adhesive layer and an extruded polyethylene coating providing an overall total film thickness that shall not be less than that specified in EN 10288. The epoxy thickness should be sufficient to provide a holiday free surface. For above ground steel pipes a triple layer polypropylene coating (3LPP) with polypropylene to EN 10286, AWWA-C215 or DIN 30678 shall be used.

Where a 3LPE or 3LPP coating is specified, the manufacturer shall demonstrate that the adhesion of the coating to the substrate does not lessen to extent that the PE coating could be easily cut or removed with time underground. The manufacturer shall carry out abrasive blast cleaning immediately before applying epoxy primer during the same work shift. In the case where steel plate or bare steel pipe is transported by sea to the place where coatings are applied, the steel or bare steel pipe as the case may be shall be subject to abrasive blast cleaning as well as phosphoric acid washing or chromate treatment immediately before applying epoxy primer during the same work shift.

All field butt welding joints shall be properly cleaned and provided with 3LPE or 3LPP coating as specified and to the Engineer's approval. The application of cold or heat process for provision of this coating has to be approved by the Engineer.

The polyethylene offered shall be HDPE.

Bidders can submit with the Bid, as an Option other coating materials with evidence and supporting standards (e.g. AWWA C213, DIN 30670, EN 10289, AWWA C215) that they are suitable for the local conditions and are proven in this respect. Bidders should also demonstrate that their manufacturers have good and long track record of providing such coating and lining materials. The Client reserves the right to select or reject any option for coating materials proposed by the Bidder without any justification.

For pipe sizes DN 400 and greater, the Contractor shall determine the native soil corrosion characteristics in accordance with DIN 50929 to confirm whether the specified pipe coatings provide adequate protection in keeping with an expected life of 50 years. The Contractor shall test along the alignment of the pipeline to a depth not less than a depth of the required trench and in any case must inform the Engineer if there is any reason to suspect the pipe coatings are not suitable for the soil.

Where in the opinion of the Engineer, native soil corrosion characteristics are worse than expected, the Engineer may require additional protection to be provided involving such measures as increased standard pipe coatings, pipe sleeving, pipe wrapping, or cathodic protection.

In particular, additional coatings might be required for highly corrosive soils with pH value under 6, or for peaty, boggy, silty or marshy soils. In the event such soils are encountered, the pipes shall be externally protected according to DIN 30674 Part 1 or equal. A dedicated item for additional corrosion protection of pipes and fittings is included in the Bills of Quantities.

b. Protection of Site Welded Joints

Protection to site welded joints shall be by a solvent free epoxy coating to AWWA C210-97 or a tape wrap to AWWA M11 as indicated in this Specification or offered by the manufacturer and approved by the Client. This specification covers the proper application and installation of approved Tape Systems for the external protection of buried, welded field joints.

The Contractor will be responsible for the application of the coating system and will furnish all equipment and properly trained and supervised labour and service required for the specified application of the coating system. The contractor will also be responsible for verifying the integrity of the coated field joint. Damaged coating will be repaired at the contractor's expense. The Contractor will supply all repair material.

The Contractor will supply a Technical Representative through an approved manufacturer of Taping Systems to assist or instruct the contractor and/or the end-user coating inspector with the proper application of the coating system.

The Technical Representative will have the authority, in agreement with the Engineer, to suspend the application of the coating system until such time as the application satisfies application and quality control standards for the coating system.

Materials Storage - All coating material will be stored, handled and transported in such a manner as to prevent damage to individual carton containers. Cartons, tape rolls or individual repair rolls removed from the storage pallets will not be dropped, rolled, or thrown in any manner as to damage the coating material. Cartons or tape rolls will not be handled with hooks, ropes, cables or any other mechanical devices that could damage the coating materials.

The coating material will be stored and/or transported in a dry, ventilated location. Storage temperature will be a minimum of 10° C and not exceed 60° C. Coating materials that have been damaged or show signs of deterioration will be inspected by representatives of the manufacturer and at the discretion of the end-user, be rejected. Primer will be stored in accordance with regulations that govern hazardous material storage. Primer inventory will rotate on a first in - first out basis. Primer containers will be marked with receiving dates.

Coating system waste material, primer containers, stub rolls, empty cartons, release liners, separator papers and related waste materials WILL NOT be discarded along the pipeline right-of-way or in the pipeline trench.

All cartons and rolls are marked with batch numbers, these batch numbers must be recorded by the applicator, each field joint that is wrapped must have the batch number of the manufacturer recorded to the weld number for easy reference.

c. Surface Preparation and Cut Back

The bare Field Joint/Fitting Surface will be prepared to a recommended standard of Sa2½ - 50 - 80µm blast profile (ISO 8501-1).

Sa2½: Near White Blast Cleaning

Removal of nearly all mill scale, rust, rust scale, paint or foreign matter by the use of abrasive propelled through nozzles or by centrifi1gal wheels, to the degree hereafter specified. A Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides or light, tight residues of paint or coating that may remain. At least 95% (percent) of each square inch of surface area will be free of all visible residues, and the remainder will be limited to the light discoloration mentioned above.

The presence of oil, grease or tar will be determined using a water spray. Where present, oil, grease or tar will be removed from the Field joint / fitting area using a non-oily solvent cleaner

(i.e. Xylene, MEK, Ethanol) and clean, lint free rags. If the above cleaning process has been carried out, the Field joint /fitting area will be rinsed with fresh potable water and dried before further processing.

Any defects in the steel substrate (i.e. slivers, laminations, etc.) will be highlighted to the clients' representative for disposition.

If the Cut Back surface temperature falls to below 10°c, the surface should be heated to achieve a faster cure.

On completion of the surface preparation, all residual grit and dust will be removed using dry, clean compressed air.

d. Pipe Lining

For sizes DN 80 up to and including DN 600, pipes shall be protected internally by cement mortar. Cement mortar lining shall conform to BS 534, DIN 2880-1 or AWWA C205. Where the water being carried is specified as being aggressive, the internal face of the cement mortar shall be further protected by a factory applied epoxy coating.

For sizes above DN 600 pipes and fittings can be lined in fusion-bonded epoxy conforming to EN 10339, DIN 2614 or AWWA C213, alternatively to cement mortar. All butt welded joints shall be properly cleaned and provided with approved epoxy as specified by the Manufacturer and approved by the Engineer.

Following butt-welding of cement lined pipes any gap in the lining will not need to be filled, provided it is a maximum of 10mm across. Otherwise it should be repaired according to the manufacturer's recommendations. The lining of epoxy lined pipes must be repaired according to the manufacturer's recommendations

e. Fittings - Coatings and Linings

Fittings shall be protected externally and internally by fusion-bonded epoxy to EN 10289, or AWWA C213 as specified by the manufacturer or required in the Bills of Quantity.

Flexible couplings and sell-sealing (grooved) couplings shall be protected externally and internally by fusion-bonded epoxy to EN 10289.

Self-sealing (grooved) coupling shall, where specified or otherwise allowed, conform to AWWA or BSCP2010-2. Bolts and nuts for such couplings shall be hot dipped zinc coated and capped nuts shall be provided. Bolts shall be an exact pre-determined length so that no bolt thread is exposed but so that the capped nut fully tightens without bearing down on the top of the bolt.

f. Coating and Lining Tests

Tests indicating the durability and robustness of the lining and coating shall be carried out as specified in DIN 30670, 30675, 30678 or equal and where relevant to the coating or lining in accordance with the requirements of the coating and lining specifications.

The supplier shall certify that their lining and coating materials conform to these tests and shall provide the Contractor testing instruments and train technicians to operate the instruments

for carrying out these tests in Kenya, or if agreed at the manufacturer's premises elsewhere. All coating and lining shall be on site tested for holiday free surfaces using the holiday testers. No pipe shall be laid having failed the holiday tests.

The Contractor shall be compensated for additional levels of protection against corrosion required by the Engineer.

2013. DUCTILE IRON PIPES AND FITTINGS – MATERIALS AND STANDARDS

For Ductile Iron Pipes, emphasis is placed on corrosion protection and therefore no compromise will be accepted in pipe thicknesses, lining and coating, so that it is ensured that the asset life is extended beyond 50 years. Ductile Iron Pipes can withstand external pressure and therefore the bedding requirements are less stringent provided however they do not negatively affect the coating. It is important therefore for the Contractor to ensure that the proposed pipe manufacturers are able to supply pipes and fittings with the specified lining and coating materials and that the manufacturing unit from where pipes are manufactured have at least five years of successful track record in supplying pipes with the required lining and coating materials. The manufacturer shall also be able to demonstrate that the lining and coating materials and application provided withstand all the necessary tests as detailed in this Specification.

Ductile Iron Pipes and Fittings shall generally comply to BS EN 545 (2010), ISO 2531 and other International Standards that specifies superior pipe thicknesses and lining / coating materials.

The Bills of Quantity specify the supply of "Self-Anchoring Ductile Iron Pipes and Fittings" which will avoid construction of large concrete thrust blocks at vertical and horizontal bends unlike the case with standard socket and spigot pipes.

For DN600 and smaller standard push-fit type joints, where specified, the Contractor's rates must include the cost for additional concrete thrust blocks at vertical and horizontal bends necessitated by these joints. Additional thrust blocks will not be paid additionally to the pipe rates!

i. Socketed Pipes

Ductile Iron Socketed Pipes shall be centrifugally cast in accordance with BS 8010 section 2.1 and EN 545. The minimum tensile strength shall be 420 N/mm^2 and the minimum 0.2% proof stress shall be 300 N/mm^2. The minimum elongation after fracture shall be 10% for nominal diameters DN 60 to 1000 and 7% for nominal diameters DN 1200 to 2000. Centrifugally Cast Ductile Iron Pipes shall be individually subjected to a works hydrostatic test of not less than 10 seconds duration.

All ductile pipes shall conform to BS EN 545 – 2010.

ii. Socketed Joints

Socketed joints shall be of the push-on type to BS EN 545 - 2010 and DIN 28603 unless otherwise specified. The material used for the rubber gaskets shall be either natural rubber or synthetic elastomer to EN 681 and EN 682, and they shall be stored in accordance with EN 2230.

iii. Flanged Pipes

Ductile Iron Flanged Pipes shall be centrifugally cast to BS EN 545 -2010.

They shall be joined using a rubber gasket of minimum thickness of 3 mm which shall be reinforced unless otherwise indicated on drawings or in Schedule of Prices and Unit Rates. The material used shall be either natural rubber or synthetic elastomer in accordance with EN 681 and EN 682, which shall be stored in accordance with EN 2230. Pipe thickness shall conform to BS EN 545 - 2010 unless otherwise indicated.

iv. Fittings

Ductile Iron Fittings shall be sand cast in accordance with BS EN 545 - 2010. The minimum tensile strength shall be 400 N/mm^2 and the minimum 0.2% proof stress shall be 300 N/mm^2. The minimum elongation after fracture shall be 5%. All fittings shall be subjected to a works leak-tightness test using water to a pressure as given in BS EN 545 - 2010.

Socketed fittings, except for collars, shall be supplied with self-anchored push-on joints unless otherwise called for. Collars shall be supplied with mechanical joint.

Flange fittings shall be fixed by rubber gaskets as indicated above for flanged pipes.

v. Marking

Each pipe, fitting or accessory shall bear the mark of the manufacturer, and indication of its casting and be marked with its nominal diameter. As appropriate, each fitting shall bear an indication of its main characteristics. Pipes, fittings and accessories with a nominal diameter of 300 mm or more shall also bear the year of manufacture. In addition, a referencing system shall be employed by the manufacturer denoting where pipes and fittings are to be stored and located along the route of the pipeline.

vi. Pipe Coating

All Coating for Ductile Iron Pipes shall be barrier coatings and conform to DIN 30675 Part 2 for Type III soil or equal unless specifically indicated otherwise.

The external coating for Ductile Iron Pipes shall be a metallic zinc spray coating to DIN 30674 Part 3 applied directly to the warm film after annealing and covered by a layer of bituminous varnish to ISO 8179-2 but shall only be used with backfill material in accordance with DIN 30675 Part 2 for Type III soils to the approval of the Engineer, and his price will be deemed to have included for the cost of this. The mass of sprayed zinc metal shall be not less than 130 g/m^2 and the thickness of the bituminous varnish not less than 70 microns. Such a coating shall not be offered for highly corrosive soils with pH value under 6, or for peaty, boggy, silty or marshy soils. In the event such soils are encountered, the pipes shall be externally protected by a factory heat applied fused polyethylene coating by extrusion or sintering, to DIN 30674 Part 1 or equal.

Where the coating offered comprises zinc and bituminous varnish, a final coat of whitewash shall be applied generally in accordance to BS 7873 to reduce heat absorption. The pipe manufacturer shall also provide a polyethylene sleeve for site protection purposes. The sleeve shall conform to EN 14628 EN 14628 and be of minimum thickness of 200 microns.

The Contractor shall determine the native soil corrosion characteristics in accordance to DIN 50929 to confirm whether the specified pipe coatings provide adequate protection in keeping with an expected life of 50 years.

The Contractor shall test along the alignment of the pipeline to a depth not less than the depth of the required trench. Where in the opinion of the Engineer, native soil corrosion characteristics are worse than the expected, the Engineer may require additional protection to be provided involving measures such as anodic backfill material, increased standard of pipe coatings, pipe sleeving, pipe wrapping. A dedicated item for additional corrosion protection of pipes and fittings is included in the Bills of Quantities.

vii. Pipe Lining

Ductile Iron Pipes shall be internally lined with a cement mortar, centrifugally applied and conforming to BS EN 545-2010 and DIN 2880.

viii. Coating and Lining Tests

Tests indicating the durability and robustness of the lining and coating shall be carried as specified in DIN 30670, DIN 30675, and DIN 30678 or equal, and in accordance with the coaling and lining specifications.

The supplier shall certify that their lining and coating materials conform to these tests and shall provide the Contractor testing instruments and train technicians to operate the instruments for carrying out these tests on site in Kenya.

ix. Internal and External Protection

Bidders can specify as option other equivalent lining and coating materials with evidence and supporting standards that they are superior and more robust. Bidders should also demonstrate that their manufacturers have good and long track record of providing such coating and lining materials.

2014. HDPE PIPES

2014.1. Standards

HDPE pipes shall generally comply with DIN 8074, DIN EN 12201 and EN 1555 or ISO 4427, or other International standards that specify superior pipe thickness. All latest and updated international standards pertaining to HDPE pipes and fittings shall apply.

- Main Lines: HD-PE 100, SDR 17, PN 10
- Consumer Connections: HD-PE 80, SDR 11, PN 10

2014.2. General

For main lines only PE100 pipes having a Minimum Required Strength (MRS) of 10 MPa shall be used. The internal and external surfaces of the pipe shall be smooth, clean and free from grooving and other defects which might impair its functional properties. The ends of the pipe shall be cleanly cut square with the axis and free from deformity. The pipe shall be homogeneous throughout and uniform in colour, opacity, density and other physical properties.

The pipe shall be delivered in the longest lengths possible to keep site jointing to a minimum, with minimum length 9m. For OD 110 and smaller diameters, coils must be supplied, with the longest lengths possible, minimum length 50m.

2014.3. Joining

Pipe jointing for pipe sizes OD 110 and bigger will be by butt-welding to form a continuous pipeline with the resulting joints as strong as the pipe itself, provided the procedures and site conditions comply with the set standards. Pipes and bends must be suitable for butt welding on site.

The ends of HDPE pipelines shall be anchored by use of HDPE Flange Adaptors to the Flange ends of steel pipes to prevent 'pull out' due to thrusts at bends and tees, together with limited movements due to thermal effects and changes in pressure.

Jointing of pipes smaller than OD 110 must be by either electro-fusion couplings or compression/mechanical couplings.

The equipment and material for electrofusion of HDPE must comply with ISO 12176-Part 2

The equipment and material for mechanical joint compression fittings must comply with ISO 14236.

For fittings smaller than OD 160, HDPE will be used, with jointing as per the pipes. For fittings OD 160 and bigger, steel fittings will be installed. However, the Contractor will also be free to alternatively propose HDPE fittings OD 160 and bigger, but in this case the Contractor will have to revise the node drawings accordingly and all costs for this are deemed included in the Contractor's rates.

Pipe Flanges will be weld on stub ends for OD 110 and bigger. Mechanical flange adaptors will be used for smaller than OD 110. Flexible couplings or flange adapters shall be provided to enable dismantling of pumps, valves, flow meters, without disturbing the pipework.

2014.4. Butt welding

The equipment and materials for butt welding of HDPE pipes must comply with ISO 12176-Part 1, and the procedures shall follow ISO 21307 and DVS 2207-Part 1.

The use of manual butt welding machines is not accepted. Butt welding must be performed using **semi-automatic butt fusion welding machines**.

With a semi-automatic welding machine the operator only operates the planer and moves the planer and heater plate in and out of the carriage. A semi-automatic machine determines the drag force, and calculates the fusion parameters based on pipe OD and SDR. It controls the entire fusion cycle including instructing the operator to remove the heater plate. If something goes wrong it aborts the cycle. Fusion parameters for each weld are recorded and can be copied and transferred (e.g. an external USB).

All fusion joint data shall be included in the "Fusion Joint Report" to be submitted to the Engineer.

2014.5. Inspection of joints

Butt-welded joints must be visually inspected on site in accordance with EN 13100-1 and ISO/TS 10839.

Whenever required by the Engineer on-site bead removal and testing in accordance with EN 12007-2 and ISO/TS 10839 for butt welded-joints must be performed:

- Remove external weld bead
- Manually bend bead to strain internal surface

Poor quality welds can occasionally be detected by twisting, rubbing and sharply pulling a knot in the bead to see if it remains in one piece.

Electrofusion joints must be visually inspected on site in accordance with ISO/TS 10839.

If required by the Engineer, destructive site testing of electrofusion joints in accordance with ISO 21751 will be performed. All costs for testing to be included in the Contractor's rates!

2015. HYDROSTATIC TESTING OF PRESSURE PIPELINES

2015.1. General

All new pipelines, including consumer connections, shall be pressure tested according to the requirements of BS EN 805 and the following section. For pipelines within a trench, such tests shall be made before backfilling is reinstated. Unless otherwise approved, all joints shall be clear of earth, timber, etc. to allow visual inspection during the test. Testing shall commence immediately upon completion of installation and preliminary backfill, and construction of thrust blocks. Pressure testing shall be carried out for sections of convenient length which shall be approved by the Engineer prior to testing. Such lengths shall not exceed 1.2km. Air testing is not accepted.

The pipeline shall be adequately anchored during the test at stop ends or valves to prevent movement under the test pressures. After filling the pipeline with water any trapped air must be bled off.

On completion of pipeline testing in sections and completion of all valving connections and other works, the whole pipeline shall be pressure tested up to at least 1.5 times the nominal working pressure for the class of pipe being tested and is to be applied for at least 2 hours. Under no circumstances shall the total time of the test exceed 8 hours at 1.5 times the nominal working pressure.

The Contractor shall supply all necessary materials to carry out the test in accordance with the requirements including force pumps, water pressure gauges, as well as tools for the use of the Engineer, interconnecting pipework, feeding tank, blank flanges, temporary stop-ends, struts and water for the test. The test section shall be capped or flanged off at each end and all branches. Testing shall not take place against closed valves. The Contractor is responsible for the water for testing and shall carry out all work which may be necessary for making temporary connections to the existing mains to obtain water, or for obtaining water by other means for testing, all at his own expense.

In carrying out the test for water tightness the Employer only shall authorize the operation of all valves, but the Contractor shall provide all the necessary labour to assist in the opening and closing of the valves to the Engineer's instructions, and he shall allow in his prices for all his expenses in connection with testing on completion.

For a pipeline incorporating flexible joints, testing shall not commence until after all the permanent thrust blocks along the pipeline have been constructed, cured for minimum 7 days, and soil around them backfilled and compacted. Capped or flanged ends along the pipeline shall also be anchored adequately to withstand the force due to test pressure. The Contractor shall submit his proposals for temporary anchoring to the Engineer's approval.

After the main has been clear of debris, and all necessary stop-ends and gauges fitted to the Engineer's approval, the Contractor shall fill up the pipe with water free from silt, sand and grit and bring steadily up to the nominal pressure of the pipe or incorporated fittings, whichever is the lesser, (except for old pipelines where a lower value may be specified by the Engineer), and this shall be maintained it with a force pump for 24 hours.

The pressure shall then be increased steadily in increments of 1.0 kg/cm^2 with a pause of one minute between each increment to the specified test pressure for the section. Unless otherwise specifically mentioned, the applied test pressure shall be measured at the lowest point along the section being tested.

After a period of half an hour, the fall in test pressure shall be recorded and sufficient water again pumped into the line under test to bring the pressure back to the test pressure. The procedure shall be repeated every half-an-hour for a total period of 3 hours, or longer, if the Engineer so directs, and the amount of water pumped in shall be recorded.

The leakage from the mains and connections from each section tested shall be according to SRN 316, i.e. not exceeding 0.02 litres per millimetre of nominal bore per kilometre of pipeline per 24 hour per bar of applied pressure head.

To determine the rate of leakage, the Contractor shall furnish a suitable hydraulic test pump, pressure gauge, connections and water meter or other appliance, for measuring the amount of water pumped. The pressure shall be raised to the amount required and specified by the Engineer and shall be so maintained for a period of not less than two hours or whatever longer period as required by the Engineer to examine every joint to satisfy himself that they are sound.

If the leakage is at a greater rate than that specified, the Contractor shall re- excavate the trench where necessary and shall re-make the joints and replace defective work until the leakage shall be reduced to the allowable amount. Faulty pipes, fittings, and specials, shall be replaced by the Contractor at his own expense and the section tested again before approval is given for backfilling. Payment for the section will not be certified, until the test has been passed and any remaining backfilling completed.

2015.2. Specific procedures for testing HDPE pipelines

Hydrostatic pressure testing in HDPE pipes shall in general comply with ASTM F 2164. If the engineer requires it, pressure testing may be conducted **outside of the trench** prior to pipe installation in order to check the welded joints.

After the pipe has been joined, it should be filled with water, carefully bleeding off any trapped air. The pipe should then be subjected to a hydrostatic test pressure that is 1.5 times the system design pressure for a maximum of 3 hours. During this time, water must be added periodically to maintain the test pressure; so as to compensate for the initial expansion of the pipe. This line pressure tightness is determined by visual observation; therefore, it is not necessary to measure the make-up water. Every fused joint must then be visually examined; any leakage must be repaired and then retested.

The procedure for **testing in the trench** is the same as described in the previous section but it must be considered that when test pressure is applied to the HDPE pipe, it expands. During the initial expansion of the pipe under test, sufficient make-up water must be added to the system at hourly intervals for 3 hours to maintain the test pressure. After about 4 hours, initial expansion should be complete and the actual test can start.

An alternate procedure consists of maintaining the test pressure over a period of 4 hours and then dropping the pressure by 10 psi (0.69 MPa). If the pressure then remains within 5% of the target value for 1 hour, this indicates there is no leakage in the system.

2016. FLUSHING AND STERILISATION

After installation and pressure testing, new water mains should be disinfected according to AWWA C651 and as described in the General Specifications, Chapter 5, Pipeline Construction Works.

Upon completion of disinfection, the system should be thoroughly flushed with fresh water, and retested to verify the disinfectant chlorine level has been reduced to potable drinking water concentrations in all service water tubing and branch lateral pipes.

Following disinfection a flow of chlorinated water must be maintained in the pipes. Hence disinfection should be carried out shortly proceeding the first connections to the system, as agreed with the Engineer, or the Contractor will be otherwise responsible of maintaining flow in the system by opening washouts or hydrants.

2017. RIVER, ROAD AND RAILWAY CROSSINGS

The pipeline route traverses a highly built up urban environment for much of its length and therefore numerous road crossings are inevitable.

For crossing of major paved roads, Trenchless Road Crossing methods must be adopted, rather than open cutting and reinstatement of the roads. Use of Trenchless Technologies for crossing of major roads is a requirement by the Roads Authorities.

Trenchless crossing will also be used for the railway crossing at Ruiru Town, at chainage Ch 8+160 and on two railway crossings in the distribution system both of them on OD 450 mm branch pipes to Mwiki.

Open cutting and reinstatement method will be used for crossing minor roads. Pipeline sections at crossings require adequate ground cover, resulting in deep excavations.

2017.1. Trenchless crossings under major roads and railways

For crossing of major paved roads and all railways, Trenchless Road Crossing methods are to be adopted. The method allowed for in the design drawings involves construction of a reinforced concrete tunnel with the crown of the tunnel located at least 1.2m below the road surface. The tunnel will be made up of 75mm thick precast C25 concrete segments arranged to form a lined microtunnel. The tunnel will have a rectangular cross section shape with an arched crown.

The space between the precast concrete lining and the excavation will be grouted on completion of placing the segments.

The Bidder may propose an alternative method of Trenchless Road/Railway Crossings including Horizontal Directional Drilling or any other suitable method. Details of any alternative method proposed by the Bidder should be submitted with the bid and the full price of which included in the respective items in the BoQ.

2017.2. River Undercrossings

The preferred design for pipeline crossings is for buried installation of pipeline. Undercrossings will be provided at river channels, streams and gullies provided that:

- Construction will not lead to serious environmental impacts of upstream and downstream environment
- The soil structure is not susceptible to movements due to ground water and will not lead to flotation of pipeline
- The water flow velocity on the river channel is not high
- The pipeline will be accessible for maintenance purposes i.e. draining of washouts

The pipeline in undercrossings will be surrounded with mass concrete.

2017.3. River Overcrossings

Overcrossings where required will be by pipeline supported on Reinforced Concrete Piers. Overcrossings will be provided in the following circumstances:

- Large river crossings where river diversion for an undercrossing would be expensive
- Where pipeline construction below ground would be difficult to undertake due to slope stability
- Rivers and streams with a steep channel slope leading to high velocity of flow
- Situations where construction of an undercrossing will lead to serious environmental violations
- Where the soil structure will not permit an undercrossing due to soil movements. Such situations, pier foundations will be driven to a solid rock
- For easy access to pipeline for maintenance and avoidance of unnecessary fittings for washouts and air valves or deep excavations

Reinforced concrete piers will be used for Overcrossings. The pipeline will be supported on a support bracket and held into position by a mild steel strap tensioned through bolting.

The foundations for the piers will be anchored on a solid ground preferably rock. Where the rock depth is deep, support piles will be driven to a solid ground.

2017.4. Exposed pipes

Sections of the pipeline will be exposed at locations such as at the aerial crossings. Considerations will be made on the support/anchorage at these sections to enhance life of the pipeline. Precautions against vandalism and pilferage must also be taken into account. Steel pipes should be used for any exposed pipeline sections.

2018. WASHOUTS

Washouts will be installed at low points in the pipeline profile and shall comprise of an invert T-Branch from the main pipe and a gate valve.

According to the Practice Manual for Water Supply Services in Kenya (MW&I, 2005), the following washout diameters are selected (d), to be installed on transmission lines of diameter (D):

- D = 800 d = 300 mm
- D = 600 d = 250 mm
- D = 500 d = 200 mm

Washouts will either discharge directly into a nearby creek / drain or include an outflow manhole, in which portable submersible pumps can be installed or from which drained water can discharge through the manhole opening. Drainage and Outfall Structures have been provided in the design to facilitate drainage of the pipeline to existing water courses without causing erosion.

Four types of Washouts have been provided in the design:

Type 1 Washouts Type 1 will be used in sections where the pipeline invert will be above the water course level. The discharge will be through a pipe to a headwall discharge to the water course.

Type 2 Washouts Type 2 will be used in sections where the pipeline invert will be below the water course level. A rising chamber (wet chamber) will be provided to raise the drainage flow to the water course level. The chamber will be covered and a manhole with cover provided for access to facilitate removal of debris and silt.

Type 3 Washouts Type 3 will be used where there is restricted space for construction of a rising chamber for the Type 2 Washout. Instead a rising pipe will be provided to raise the drainage flow to the water course level. The rising pipe will be DN500 and will blanked at the top side to facilitate removal of debris and silt. The washout will also be provided in under river crossings where a rising chamber will be subject to flooding.

Type 4 Washouts Type 4 will be used in sections where the pipeline invert will be high above the water course level and with steep slopes. This includes aerial crossings by either bridge or piers. Outfall chambers and cascades will be provided to direct discharge flow to the water course without causing erosion

2019. VALVES

2019.1. General

Isolating valves up to and including DN 300 shall be gate valves, and valves larger than DN 300 shall be butterfly valves, except where otherwise specified. All valves for use in water supply shall conform to BS EN 1074.

All valves shall bear an identification mark on the upper body that shall include:

i) Name of the manufacturer and/or his trade mark;
ii) Nominal diameter (DN);
iii) Nominal pressure (PN);
iv) Project Name or Client's name embossed and

The manufacturer's full technical specifications shall be supplied to the Engineer in triplicate by the Contractor for approval prior to confirmation of any order for valves.

Face to face dimensions of valves must be as per EN 558-2 and flanges must be drilled to EN 1092.

The valve body shall be cleaned and shot blasted to ISO 8503 Parts Ito 4 before being internally and externally protected. All isolating valves shall be protected by fusion bonded powder epoxy, internally suitable for potable water, to DIN 30677-2, or equivalent, coating thickness: min. 250 μm.

Seals, seats and other wearing parts, where applicable, shall be of suitable corrosion proof material.

All valves shall be designed to conform to the pressure rating of the pipeline section and should be minimum PN16, except where otherwise specified. All valves shall close when the stem rotation is in a clockwise direction unless otherwise specified.

- With each valve either a handwheel or suitable key for operation must be supplied
- Minimum three keys for each valve type must be supplied in addition.
- For butterfly valves the shaft must be in the horizontal position, to limit the depth of the required valve chamber, unless otherwise specified

Bidders shall supply full technical details of the proposed valves to be supplied with their Bid. If the Engineer considers the proposed valves to be not satisfactory, he will reject them and instruct the Contractor to provide a suitable alternative. No additional payment shall be made where such changes occur.

2019.2. Air Release and Vacuum Break Valves

Air valves shall be provided at all high points in pipework to release accumulated air during normal pipeline operation, to vent air from the pipeline during pipeline filling, to admit air during draining operations and to avoid negative internal pressures which could damage the pipeline.

All Air Valves shall be Double Orifice Air Valves (DAV) and shall be provided with separate isolating gate valves to facilitate their easy removal and repair. The Air Valves shall be of the anti-shock and anti-surge type designed to meet the following requirements:

Pipeline Filling - Uninterrupted high volume air discharge through the large orifice.

Pipeline Draining or Column Separation - Uninterrupted high volume air intake through the large orifice.

Pipeline Full and Operating - Discharge of dis-entrained pressurised air through the small orifice.

The air release and vacuum break valve shall be of a compact single chamber design with solid cylindrical High Density Polyethylene control floats. These shall be housed in a tubular stainless steel or corrosion protected body with epoxy powder coated cast iron, or stainless steel ends secured by means of stainless steel tie rods.

The valve shall have an integral surge alleviation mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure due to high velocity air discharge or the subsequent rejoining of separated water columns. The limitation of pressure rise must be achieved by deceleration of approaching water prior to valve closure. Relief mechanisms that act subsequent to valve closure are unacceptable.

Large orifice sealing shall be effected by the flat face of the control float seating against a nitrile rubber '6' Ring housed in a dovetail groove circumferentially surrounding the large orifice. Discharge of pressurised air shall be controlled by the seating and unseating of a small orifice on a natural rubber seal affixed to the control float.

The intake/discharge area shall be equal to the nominal size of the valve i.e. a 150 mm valve shall have a 150 mm intake/discharge orifice.

The valve construction shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur by submission to twice the designed working pressure.

The valve design shall incorporate an over pressure safety feature that will fail without an explosive effect, as is normally the case when highly compressed air is released suddenly. This feature shall consist of easily replaceable components such as gaskets, seals or the like.

The air valve shall be provided with a built-in separate isolating valve.

Unless otherwise specified all air valves shall be provided with an integral flanged inlet with studs appropriate to EN 1092-1 NP 10 or as the installation demands and complying with the appropriate nominal pressure.

All air valves at new installations shall be fitted to an air accumulator fitting, with the branch diameter not less than 60% of the diameter of the main. Where necessary, a concentric taper either integral with or as a separate fitting shall be inserted between the branch and the isolating valve immediately beneath the air valve and an abrupt diameter change between branch and isolating valve shall be avoided.

Air valves shall be of approved manufacture and pressure rating indicated on drawings or in Schedule of Prices and Unit Rates.

2019.3. Pressure Reducing Valve (PRV)

The PRV should reduce automatically a higher inlet pressure to a lower outlet pressure. The outlet pressure is kept constant, regardless of changes in flow rate or inlet pressure. The main control valve is pilot operated, capable of precise setting and easy adjustment of outlet pressure.

The product shall be a flanged, full bore, diaphragm operated control valve with lifted seat and parabolic plug. The body shall be made of ductile cast iron acc. to EN 1563 grade GJS-500-7 internally and externally corrosion protected with fusion bonded epoxy. The control module block and its internals shall be made of stainless steel AISI 316. The piping, shut-off valves, unions, etc. constituting the connection between main valve and control module block and the main valve parts like seat, plug, etc. shall also be stainless steel AISI 316.

2019.4. Hand-Wheels for Valves

Hand-wheels for valves shall have cast into them the words 'open' and 'close', together with an arrow indicating the direction for such opening or closing. Valves for tee- key operation shall be provided with valve caps.

2019.5. Valve Keys

These shall be of mild steel with ends to suit either valves to BS 5163 Parts 1 and 2, valves to EN 593 or valves to EN 12360 or 12288 fitted with valve caps.

2019.6. Valve Chamber and Covers

New chambers shall be constructed in accordance with the drawings, and where indicated, shall incorporate thrust walls. Notwithstanding the size and shape of the valve to be supplied, the Contractor shall ensure that the minimum clearance as indicated on the drawings are provided within the chamber.

All chambers shall be equipped with step irons as per DIN 1211, DIN 1212 and DIN EN 13101, in cast-iron/steel with rubber/plastic coating, integrated to form a ladder. The step irons only fixed by approved fixing system of dowels or anchors, which do not weaken water tightness or integrity of the chamber structure. A pump sump will be built in each chamber as shown on the drawings, with a minimum depth of 200 mm and a concrete screed on the bottom of the chamber to allow drainage with a conventional drainage pump.

Valve chamber covers shall be antitheft lockable composite covers or antitheft lockable reinforced concrete with a weight of minimum 50 kg per piece and provided with embedded steel device for

lifting at each end. All covers should be DN600, minimum Class B125 according to EN 124, for occasional vehicular loading, and watertight. They shall be supplied complete with hidden locking mechanisms and lifting keys.

Except where a chamber is provided with pre-cast roof slabs to facilitate placing and removal of the valve or valves within the chamber, the clear opening in the chamber cover shall in all cases allow for this. It will be the Contractor's responsibility to ensure that the covers he provides are of an appropriate clear opening size. Removable concrete roof slabs must be provided with lifting eyes.

Chambers for flow measurement will be as per the valve chambers.

2019.7. Valve Boxes

Valve chambers will be used for valves DN 400 and bigger and at the borders of DMAs. In urban areas where space is restricted, concrete pipe valve boxes are specified in lieu of chambers. These buried valves will be installed with a flange on one side and an end restraint flange adaptor on the other.

Valve boxes will have height adjustable surface boxes from synthetic material, DVGW Approved, e.g. PA+, to DIN 4055 or 4056 or equivalent They must be lockable, with hidden locking mechanisms, minimum Class B125 according to EN 124, for occasional vehicular loading, and watertight.

2020. FIRE HYDRANTS

Underground fire hydrants DN 80, PN16, with double locking device, shall be installed as per the requirements of BS 750 and BS EN1074-2:2000 and EN 14339:2005, underground hydrants, suitable for potable (drinking) water.

Hydrants are paid by a lump sum including all necessary works, parts and fittings for the hydrant and the connection to the main pipe. NOTE: The contractor has to verify that existing equipment at the Ruiru Fire Department is compatible with the new hydrants before ordering!

Hydrant indicator plates shall be mounted at an appropriate site. Fire Hydrant covers shall be vandal proof and lockable, as per the requirements for valve covers.

2021. FLOW MEASUREMENT

2021.1. General

All flow meters require data loggers with GPRS transmission and antennae, and the Contractor is responsible for supplying and installing all items, other than the SIM card itself, which will be provided by the Employer, who will also cover any contract or operating fees, apart from what is needed for testing.

Pressure measurement will also be made possible by including an attachment for a pressure gauge by all flow meters, but outside the straight pipe length, so the flow meter accuracy is not affected.

All elements in the chamber shall have IP68 protection. The chambers could be flooded and the equipment shall be fully submersible.

2021.2. Battery requirements

There will be no connections to the power mains. All elements (water meters, data loggers, transmitters, etc.) will be battery powered. The minimum battery lifetime has to be 5 years.

Installation of external battery packs in the chambers to extend the lifetime of batteries included in metering devices will be accepted. For such battery packs a separate shelf or box with the required cabling must be installed at a place safe from water and easy to access.

All elements will be supplied and installed with batteries included; and the costs will be included in the items of the BoQ. The need for battery replacement must be indicated by a symbol shown on the displays.

Where a transmitter is specified, it must be possible to obtain information on the overall battery level of all metering devices via GPRS communication system!

2021.3. Security devices

Where a transmitter is specified, a sensor will be installed under each chamber cover, and it will be programmed to send an alarm if it detects any unauthorized entry to the chamber.

2021.4. Zone Metering Chambers

The zone metering chambers shall be to the same specifications as valve chambers. Concrete supports for flowmeters and valves will be installed as required.

2022. FLOW METERS

2022.1. General

All flow meters supplied and installed shall be compliant to ISO 4064 and have approval to European Directive 2014/32/EU.

Water meters in bi-directional points will be ultrasonic flow meter with bi-directional measurement., otherwise Woltman Flow Meters will be installed. Flow meters of other types (e.g. electromagnetic, Coriolis flow meter, etc.) will not be accepted.

The water meters shall be installed with straight lengths upstream and downstream as specified by the manufacturer in order to achieve the required accuracy. However, in order to minimize the pipework and chamber sizes a maximum acceptable length of required upstream and downstream straight pipe sections is specified below:

Flowmeter DN	Maximum upstream straight length	Maximum downstream straight length
32-40	10 x DN	5 x DN
50-300	5 x DN	3 x DN

If any flowmeter requires longer straight lengths to achieve the required accuracy then the cost for the greater chamber size will not be paid additionally. The flange dimensions and drilling of flanged flowmeters must be according to EN 1092-2 PN 10.

The manufacturer specific requirements must be strictly followed for flow meter storage, transport and installation, particularly regarding minimum straight lengths and electrical connections.

2022.2. Calibration

The meters must be supplied calibrated and in a fully operational condition. Calibration must be proven by submitting certificates according to the Measuring Instruments Directive (MID).

Re-calibration shall be performed after installation of the instrument when required by the Engineer if there were doubts about the calibration status of the flowmeter.

2022.3. Definitions

The following terms to ISO 4064-1 shall rule:

Maximum Permissible Error, MPE. Extreme values of the relative error of indication of the water meter permitted by ISO 4064.

Rated Operating Conditions, ROC. Conditions of use giving the range of values of the influence factors, for which the errors of indication of the water meter are required to be within the MPE.

Minimum flowrate, Q1. Lowest flowrate at which the water meter is required to operate within the MPE

Transitional flowrate, Q2. Flowrate which occurs between the permanent flowrate, Q3, and minimum flowrate, Q1, that divides the flowrate range into two zones, the “upper zone” and the “lower zone”, each characterized by its own MPE

Permanent flowrate, Q3. Highest flowrate within ROC at which a water meter is required to operate in a satisfactory manner within the MPE

Overload flowrate, Q4. Highest flowrate at which a water meter is required to operate for a short period of time within its MPE, whilst maintaining its metrological performance when it is subsequently operated within its ROC

2022.4. Rated Operating Conditions

The ROC are determined by the following conditions:

- Temperature class T50 (0.1°-50°C)
- Water pressure class MAP 10 (Max water pressure 10 bar)
- Ambient temperature between -5°C and +55°C.

2022.5. Requirements

The MPE, positive or negative, on volumes delivered at flowrates between the minimum flowrate Q1 and the transitional flowrate Q2 (excluded) is 5 %

The maximum permissible error, positive or negative, on volumes delivered at flowrates between the Q2 (included) and Q4 is, for water having a temperature within ROC:
– 2 % for water temperature ≤ 30 °C;
– 3 % for water temperature > 30 °C.

These requirements for the flow meters to be installed under this contract are obtained from the DMA design. The minimum and permanent flow rates (Q1 and Q3) and the associated velocities are calculated as 5% and 300% of average flow from hydraulic model.

The minimum requirements are summarized in the following Table. The indicated values for Q1 and Q3 shall be understood as maximum and minimum admissible and they define the working range of the flowmeters within the MPE.

The average flow indicated in the table will be between Q2 and Q3, so that the error at this rate is minimum.

The accuracy requirements must be proven by conformity certificates according to MID

Table of Flow Meters to be supplied and installed:

Flow meter ID	Existing Pipe OD	Flow meter DN	Max. Design Flow Q 2040 (l/s)	Q 2040 (m³/h)	Q3 (m³/h)	Q1 (m³/h)	R	Velocity for Q (m/s)	Velocity for Q1 (m/s)
MWA1	110	50	4.2	15.0	25	0.03	800	2.12	0.00
MWA2-B	110	50	3.0	10.9	25	0.03	800	1.54	0.00
MWA3-A	90	50	2.1	7.7	25	0.03	800	1.08	0.00
MWA4-A	160	50	4.6	16.6	25	0.03	800	2.34	0.00
MWA4-B	90	50	2.4	8.8	25	0.03	800	1.24	0.00
MWA4-C	160	50	4.3	15.3	25	0.03	800	2.16	0.00
MWA2-A	560	100	12.4	44.6	100	0.13	800	1.58	0.00
MWA2-C	560	100	7.8	28.0	100	0.13	800	0.99	0.00
MWR-1	560	150	45.3	163.0	250	0.31	800	2.56	0.00
MWR-2	355	150	28.5	102.6	250	0.31	800	1.61	0.00

2022.6. Ultrasonic water meters

USFM shall comply with the following design characteristics:

- USFM shall be flanged, battery powered.
- Operating pressure 10 bar.
- No moving parts.
- USFM method shall be based on single or dual-beam sensors.
- USFM shall be designed for bi-directional flow measurement.
- Ambient operation temperature: -10°C to +55°C
- Pressure loss class: max ΔP 0.25 bar
- Cast iron body, epoxy coating. Stainless steel body also accepted.
- Approved in accordance with MID
- Flowrate sampling period: at least 1 second.
- Battery powered up to minimum 5 years
- Q3/Q1 Ratio: R800 or higher.
- supplied calibrated in minimum 10 points according to standard EN 14154.

Following functions:

- Storage of the measured data on instantaneous flow rate, pressure (when pressure measurement integrated) and aggregate volume
- Digital display with visual indication of the flow rate direction, instantaneous water pressure and flow rates.
- Display must have options to set counters at least on: L/s, m3/h,
- Switching display values must be at site, on device, intuitive, easy, fast and without PC
- Low battery alarm which can be sent by data transmission

Either compact version (the signal converter is mounted directly on the measuring sensor) or remote version (electrical connection to the measuring sensor via signal cable) are accepted. The connecting cables must be protected in stainless steel pipes and fixed with stainless steel bolts.

The water meter's electronic register shall include an integrated cable (or a separate module) with industry standard outputs fully compatible with GPRS data logger device without external power supply. Operating language: English. Ancillaries: Owners manual in English

The flow meters are provided with insulated communication interface (USB, RS232 line, or similar) facilitating:

- Reading of all measured quantities:
    - Instantaneous flow rate + /-
    - Aggregate fluid volume passed through the meter sensor + /-
- Flow-meter parameter setting

2022.7. Woltmann water meters

Woltmann water meters shall comply with the following design characteristics:

- Equipped with dry-dial register with optimum readability.
- Suitable for fluctuating flow rates, with measuring insert replaceable without removal of body.
- Fully compatible with the datalogger and transmission devices

- Suitable for cold water (0°- 50°C).
- Operating pressure 10 bar
- Pressure loss class: ΔP 40 or better.
- Ambient operation temperature: -20°C to +55°C
- Meter body in cast iron, epoxy coating
- Robust, for extreme applications.
- Suitable for horizontal installation.
- Completely water proof register, magnetic transmission and registration, shielded against tampering or any external magnetic field.
- Approved in accordance with MID
- Q3/Q1 Ratio: R160 or higher.
- Display of instantaneous water flow rate.
- Maximum length face to face according to **Error! Reference source not found.** Table:

Diameter	Length (mm)
50	200
65	200
80	225
100	250
125	250
150	300
200	350
250	450
300	500

Water meter electronic register shall include an integrated cable (or a separate module) with industry standard outputs fully compatible with the supplied datalogger device and GPRS transmitter.

2022.8. Domestic water meters for service connections.

The meters shall be high quality and robust for long term performance, high accuracy and reliability. They must be from a well-recognized manufacturer that has supplied similar domestic meters internationally for at least 10 years to ISO and OIML standards.

The meters must comply with EN ISO 4064: 2014, OIML R 49 :2013 and MID 2014/32/EU. The meters shall be the volumetric type (positive displacement meter), R=160, accuracy class 2, for installation in in any position (except overhead).

Water meters to be equipped with integrated but easy exchangeable inlet strainer (mesh filter basket) and backflow preventer.

The meters must be pre-equipped for converting it into a communicating meter, ready for mobile or fixed network (radio/wired) reading.

The meter must be new and manufactured in the year of delivery. The domestic water meter shall be supplied as a complete kit with BSP threaded inlet and outlet tail coupling kits for connection to water pipes.

The materials used in the construction of the meter should be designed to withstand treated (potable) water supplied to WHO International regulations, for the climatic conditions of Nairobi

City area, and to operate normally for 5 years without any need for normal maintenance or repair and without the maximum error exceeding the specified limits. The domestic water meter must be constructed throughout of materials which are resistant to internal and external corrosion and if necessary be protected by some suitable surface treatment. All materials of the water meter which are in contact with the water flowing through the water meter shall be non-toxic and non-tainting and this shall be certified by a recognized authority. Water temperature variations within the working range shall not affect the materials used in the construction of the water meter.

The meter sizes DN15 and DN20 must have composite housing/casing, brass will not be permitted.

For DN25 and bigger, the meters can have brass housing/casing.

Strainers: The meter shall have an in-built strainer screen, which shall be rigid, fit snugly, be easy to remove and have an effective straining area at least double the main casing inlet.

Reverse Flow Restrictor / Non-return Valves:
All meters must be fitted with an in-built non removable maintenance free non return valve that shall prevent meter reversal.

2023. DATALOGGING AND TRANSMISSION

All flow meters under the contract require data loggers with GPRS transmission and antennae, or alternative approved wireless transmitters.

Data logger devices must be able to store (log) simultaneously these values:

- Date
- Time
- Flow rate
- Flow velocity
- Volume (total counter)

Data capacity must be minimum 100.000 measuring values in format which will be easy transferred.
The data logger shall have the capacity to transmit the following data:

- Flow measured by the water meter

In addition, it should be prepared to transmit a low battery alarm by GPRS. The datalogger must be programmed to send alarms via SMS.

The transmitter must transfer the data on a daily basis via GPRS to ftp server or via e-mail. The data will also be stored in a cloud storage system and it shall be possible to access the data anytime on any internet enabled device. It shall be possible to configure the device in other frequencies for data transfer down to minimum 10 minutes. It shall be possible to establish real-time communications with the datalogger for updates or reconfiguration, without the need for a site visit. Serial connector must be included for local data download and reconfiguration.

The data logger shall have a minimum battery lifetime of 5 years considering a minimum of 1 daily data transfer. Working temperature range: -20 to +50° C. Minimum 3 digital inputs and 1

analog input.

The dataloggers must be programmed by the Contractor, with the latest available firmware installed and be completely functional for taking over. The Contractor will organize a training session with personnel chosen by MVK to explain the operation and settings.

Where installed in chambers, the dataloggers and external batteries (if any) shall be positioned on top of the chamber to avoid unnecessarily submerging if the chamber is flooded.

The price for flow meters, data loggers and transmitters shall include all supplies, works and set up for fully functioning units, except for the cost of any SIM card or phone contract, which will be covered by the water utility.

If the Contractor demonstrates that in some cases it is not possible to install antennae in the chambers, due to poor network reception, then this must be agreed with the Engineer. If agreed, then antennae will be installed in a secure, wall mounted box in the vicinity of the flow meter and the Contractor will receive extra payment for this variation.

2024. LAYING AND INSTALLATION OF PIPES

Mains running parallel to or crossing foul or combined sewers should be located at higher levels, or if not possible, adequate precautions should be taken to preclude the ingress of contaminated water to the main.

Before pipes are laid, the trench shall be checked for correct depth, gradient, width and condition of the trench bottom. Trenches excavated for pipe laying should not be open for extended periods in advance of pipe laying and should be backfilled as soon as possible. It is essential that the sides of the trench are adequately supported during pipe laying. Trench widths should be as narrow as is practicable, but adequate so that sidefill can be placed.

Due to cost and environmental reasons, excavated material from trenches will be re-used as far as possible for bedding, surround and backfill. The Contractor must take reasonable precautions to ensure excavated materials is reusable, such as protection from the elements, or sorting and processing it on site, including sieving if required. Where rock is encountered, pipes are to be laid on imported granular bed and surround.

The density of the pipe surround and backfill material will be regularly checked. In particular, several checks will be made during start-up of the project to ensure that the compaction procedure is achieving the desired density. Random checks will then subsequently be made to verify that the materials or procedures have not changed. Checks will be made at different elevations of the embedment material to assure that the desired compaction is being achieved throughout the embedment zone.

The final pipe route will be marked with posts or marker plates for pipe protection and maintenance. These will be provided at relevant locations, like gate valves, washouts, fire hydrants, etc. and along pipelines at every 200 to 400m, except where they follow permanent roads.

21.RING MAIN AND DISTRIBUTION SYSTEM

Note: The Contractor must also refer to the other parts of the Particular and the General Specifications, particularly regarding pipes, fittings and pipeworks.

2101. GENERAL DESIGN CONCEPT

The ring mains and distribution to be installed is detailed on the drawings.

On the ring mains, size DN 600 – OD 355, air valves, washouts and anchor blocks will be installed as per the transmission mains. For smaller pipes in the distribution system these are generally not required.

Consumer connections are generally connected to OD 225 and smaller pipes. For pipes DN400 and larger, parallel pipes for consumer connections shall be laid,

The proposed location of water pipes is only shown indicatively on the drawings. Prior to setting out the pipe routes the Contractor must agree the position with the Engineer and the RAP coordinator. The final pipe route must then be confirmed by the Contractor, following his additional surveys and site investigations, and then included on the shop drawings for submission to the Engineer. Pipe works can only commence once the shop drawings are approved.

Parts of the project area are currently supplied by an old, existing system, supplied by Nairobi City Water and Sewerage Company. During the construction of the new water supply system, the Contractor will be responsible for not damaging the old, existing water supply system, which must remain functional. Therefore the Contractor should be prepared to temporarily support this existing system where it crosses the trench and must carry out temporary repairs if major leakage is discovered. Following completion of the new water supply system under this contract, the Contractor must disconnect the inflows to the old existing system and so permanently take it out of operation.

Some of the project area also has sewer collectors. Details of the existing water and sewer systems are shown on the drawings, though these are for information only and are not comprehensive or accurate. For all services the Contractor is responsible for determining the actual positions through contacted the relevant providers and carrying out investigations on site.

2102. SEQUENCING OF WORKS

Works on the ring mains and distribution system should continue in parallel, but consumer connections cannot be completed until the new system is pressurized, tested, flushed and disinfected.

2103. MATERIALS

Pipes of diameter OD 355 or smaller shall be made of PE-HD PN 10, for larger diameters ferrous pipes shall be used. All pipes and fittings shall conform to the General and Particular Specifications, in particular Section 21, Water Pipelines.

2104. NODE DETAILS

All crossings of pipes, and points where fittings are to be installed, are referred to as "Nodes". These have been prepared in detail, however, the Contractor will have to check the requirements and revise the node plans if necessary. In some locations the existing situation can only be determined by search excavations on site.

Any proposed change in pipe routing must also include the new node drawings and bills of material.

2105. CROSSINGS

2105.1. Road, Rail and River Crossings

The general requirements for road, rail and river crossings are already described in Section 21, Water Pipelines. For these standard designs and drawings have been prepared, which must be finalised by the Contractor prior to the works.

Major crossings on the pipe route are as follows:

Road Crossings
The pipeline route traverses a highly built up urban environment for much of its length and therefore numerous road crossings are inevitable. For crossing of major paved roads, the Contractor must adopt Trenchless Road Crossing methods rather than open cutting and reinstatement of the roads. Open cutting and reinstatement method will be used for crossing minor roads.

Rail Crossings
These require Trenchless Methods.

River Crossings
There are 2 No river crossing. Steel pipes will be sued for along the bridge in line with contract specifications.

2105.2. Stormwater Channels

The designed pipe routings, including consumer connections, will cross existing open storm water channels, which run alongside many roads. Stormwater channels are frequently heavily contaminated with solid waste, run off and sometimes wastewater, hence it will be important to protect the water pipes from cross-contamination. Also, the Contractor should be prepared for working alongside these channels and pipelaying rates must include the cost of dealing with stormwater and wastewater.

For crossing stormwater channels different standard designs have been prepared for the different situations to be encountered; for example size and depth of channel; material of channel construction; size and depth of water supply pipe crossing the channel, etc. The selected method will be subject to approval by the Engineer during the construction works.

Generally the water pipes should be laid underneath the channel and protected from contamination

either with a sleeve pipe or with concrete surround. For wider and deeper channels, particularly where crossed numerous times by consumer connections, an alternative will be to pass the pipe through the channel at a level higher than the channel bottom. This shall be done by pressing a PVC sleeve pipe and using pipe spacers to support the water pipe, with a minimum distance between channel / pipe bottom and protection pipe of 50 cm specified so that the channel does not become blocked.

For payment, the Contractor will only be paid for concrete surround or the sleeve pipe, in addition to the usual pipelaying rates, for crossing earth and unlined channels.

For any rock lined or concrete stormwater channels an additional payment will be made for crossing these, per piece, including reinstatement to the original condition.

2105.3. Wastewater System

The only sewer system known about in the project area is the recently constructed Kiu River collector, which serves parts of Kahawa Sukari and Kahawa Wendani. The Contractor has been provided with the details of this system, but it is not expected that the information is completely reliable.

In any case the Contractor must liaise with the relevant authorities and service providers and carry out site investigations to confirm the position of sewers and all other services on site. The pipe alignment must then be designed to take the sewers into consideration.

In general the water supply pipes should always be laid above the sewer pipes, or, where this is not possible, the water pipes must be protected from cross-contamination with either a sleeve pipe or concrete surround. For all services a minimum distance of 0.3m should be maintained between the pipes and existing services.

2105.4. Septic Tanks

It is expected that during the works illegal septic tanks and soak-aways might be uncovered, which have been constructed outside the respective properties inside the road body or wayleaves. These will either need to be removed by the property owners, or the water main will have to be diverted past them, with protection installed to prevent contamination. These will be dealt with on a case by case basis, in conjunction with the respective authorities and the Engineer. The Contractor should include all costs for dealing with any leaking septic tanks, in accordance with environmental or H&S regulations, in his rates.

2106. Pressure Reducing Valves (PRV)

The Mwihoko water supply system requires the pressure reducing compared with the adjacent Greater Githurai system. Therefore two PRVs are required, one on each ring main.

The dimensions of the PRVs have been selected according the maximum design flow and inlet and outlet pressures, as established by the hydraulic model. The table below lists the required PRVs. However the Contractor must confirm the dimensions with the specific manufacturer prior to ordering so as to ensure a stable operation of the PRV and minimum water hammer.

PRV ID	Existing Pipe OD	Max. inlet pressure (m)	Min. inlet pressure (m)	Outlet pressure (m)	Max. Design Flow 2020 (l/s)	Min. Design Flow 2020 (l/s)	Calculated DN
MWR-1	560	58.0	57.5	42.4	27.6	4.6	DN125
MWR-2	355	32.6	28.8	17.0	7.8	1.3	DN50

All PRVs require a bypass, with pipe diameter the same as the PRV dimension, with valves for closing the PRV and opening the bypass, for PRV maintenance. PRVs also require attachments for pressure gauges upstream and downstream of all PRVs for set up and monitoring purposes.

2107. CONSUMER CONNECTIONS

In the distribution system all existing Nairobi Water (NCWSC) consumers must be connected to the new water supply system, so that at the end of the project the old, existing system can be taken out of operation. and also any new consumers who have their application for a connection accepted by RUJWASCO by the cut off date will also have a connection constructed.

Consumer connections are not shown on the layout drawings, because the available lists of consumers are currently being cross-checked and validated on the ground. Hence only standard drawings are provided and the consumer connections are included in the BoQ.

The Contractor will be responsible for constructing the consumer connection as far as the border of the private property, where the Contractor must install a water meter chamber, including meter installation set. The connection pipe shall be temporarily sealed by the Contractor, until RUJWACO make the final connection to the consumer. Consumer connection lines must be pressure tested and disinfected by the Contractor, as per the main lines.

All consumer connections will be metered and the respective water meters will be procured by the Contractor. However, the water meters will be installed by RUJWASCO. RUJWASCO will also complete the connection of the water meter box to the internal plumbing of the consumer, and thereby commission the connection.

As part of the Contractor's works programme, it must be shown on which streets the Contractor intends to work, and then this programme will need to be updated to match progress or any changes. The Contractor must notify the Engineer of when pipelines will be laid in each street, giving 3 months notice, and then the Engineer will coordinate with RUJWASCO so as to provide the Contractor with the consumer connection concept for the respective street, within 2 months of the Contractor's notice, i.e. a minimum of 1 month before the Contractor implements the works.

The consumer connection concept provided to the Contractor will show:

- The routing of consumer connection lines between main line and connection point to in-house installation of the building
- Water metering concept (with or without master meter)
- No of households in the building to be connected, or expected maximum consumption if not an apartment block.
- Site of metering chambers
- Point where to install pipe saddles or connections with Tee piece on the main line

Based on the consumer connection concept provided by the Engineer, the contractor shall prepare Construction / Shop drawings, for the planned house connection installations, which must then be

approved the Engineer. These drawings shall include:

- Position of all installations (pipes, connection points to main distribution system pipe and in-house installations, water meter housing boxes, position of master meters (if any), valves, etc.)
- Diameter of consumer connection pipes (based on agreed dimensioning rules to supply the immediate demand).

The aim will be that all connections (new or replacement of existing) should be done by the Contractor at the time he is laying the new distribution line down the street, to cause the least disruption. However, the Contractor should include in his rates the additional costs for up to 10% of connections to be installed after the main line is completed, i.e. the Contractor has to return to do these connections on an ad-hoc basis, for no extra payment.

House connections will be taken over at the same time as the respective distribution system, as complete DMAs as a minimum, and only when there is a source available to pressurize the system so that RUJWASCO can immediately start commissioning the connections and operating the system, following taking over.

2107.1. Materials of Consumer Connections

All installations, unless otherwise stated in exceptional cases, shall be for a working pressure of PN 10, and be minimum PE-HD 80, SDR 11.

Consumer connections shall be connected to the main distribution pipe by either a Tee piece, with compression fittings for smaller diameters, or a pipe saddles of either mechanical or electrofusion type.

Pipe saddles must be corrosion protected, with nitrile rubber (NBR) or elastomer gaskets, and galvanised or stainless steel bolts.

Mechanical clamp saddles must be of the underclamp type, ensuring a full contact between the saddle and the entire diameter of the PE pipe. Clamp materials either ductile iron, epoxy coated, to EN 1561 or 1563, or PP polypropylene.

Water meter boxes must be water tight, UV resistant, of PE or similar WRAS approved materials, with moulded two-piece telescopic chambers, allowing for easy and precise surface level adjustment. Covers must be of composite material, anti-theft and lockable, with keys supplied.

Water meter boxes and covers must be installed suffice for a minimum of bearing load Grade C load bearing according to WIS 4-37-01, capacity of over 20 kN.

Details of the water meters supplied under the separate contract (detailed dimensions) shall be provided to the works contractor in time, so that he can adjust the dimension of the water meter chambers, installation equipment and appurtenances. Maximum length face to face according to following table:

Diameter	Length (mm)
20	350
25	350
32	380

40	450
50	450

2108. TAKING INTO OPERATION, TESTS ON COMPLETION AND TAKING OVER

For the distribution system, taking over of part of the works will only be considered for complete DMAs, including consumer connections, as a minimum, unless otherwise agreed with the Engineer. Tests on completion will include:

- Pressure testing, flushing and sterilisation of pipes
- Completion of reinstatement
- Inspection and testing of valves, washouts and chambers to ensure compliance with contract, including:
    - Chambers will be checked during wet weather for water tightness
    - Valves will be operated and tested for vibrations and closing, in both metering and valve chambers.
    - Battery life of all elements will be checked
    - Dataloggers and transmission devices are tested by sending data as follows:
        - Flow data from flowmeter is stored
        - The data package is sent
        - Data package is successfully received and accessible
        - Information on battery lifetime is obtained remotely

Pipe sections within the network must be step wise pressure tested during the works, because the laying of a large length of pipes without testing will not be permitted. However, the final tests on completion can only be done once the network is pressurised. This will include pressure testing the consumer connections as far as the metering box, where the consumer connection will be capped, until they are later connected to the Consumer's internal plumbing by RUJWASCO.

Disinfection should only be carried out directly prior to when the consumer are connected. After taking over the Contractor may still have to operate valves or hydrants in the system to ensure sufficient flow and prevent stagnation, until enough consumers are connected by RUJWASCO. This will be as per the instruction of the Engineer.

2108.1. Report on Tests on Completion

The Contractor shall compile all test protocols, certificates, test results (also from the "tests during construction") material certificates etc. in a report and add a concise overview and final conclusion proofing that he has passed all specified tests.

The report to be submitted to and accepted by the Engineer prior to taking over.

2109. TRAINING

The following specific training must be performed by suitably qualified and experienced trainers:

Items	Training to be provided on	Minimum Training Days
Water Supply System:		
General system layout and function	Description of new system and function	0.5 day theory for up to 30 staff
General components of the distribution system like pipe material, valves, house connections	Valve operation and maintenance, hydrant maintenance, pipe connections, connecting of service lines, water meter boxes installation, PRVs operation and maintenance	1 day theory, 2 days practical, for maximum 10 staff
DMA zone metering concept and flow measurement.	General theoretic concept of Zone metering and water balancing for NRW management Basic troubleshooting and handling of electronic devices Settings and configuration Maintenance of equipment	1 day theory, 1 day practical, for maximum 5 staff

Training must be carried out on the basis of the approved O&M manual.

The CVs of proposed trainers and the training programme must be submitted to the Engineer for approval, in advance of training. The Contractor is also encouraged to involve the expertise of suppliers and manufacturers for training, as appropriate.

The completion of training must be certified by RUJWASCO and by the Engineer.

22.ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN (ESMMP)

The Contractor must implement the works to strict environmental, social and health and safety standards and a high level must be achieved, in accordance with Kenyan Statutory requirements and the applicable international standards. This will be strictly monitored and enforced by the Engineer, with non-conformances notified and repeat violations, or serious non-conformances, will result in a stop of the respective works until the discrepancies are rectified.

The main requirements are stated in the General Specifications, Chapter 2, Environmental, Social, Health and Safety Management of the Works and also in the Environmental Management Plan, prepared for the project as part of the Environmental and Social Impact Assessment, which is summarized in section 2203.

In particular the following apply:

i. Within 28 days of Commencement at the latest, the Contractor shall submit a Project Specific Environmental and Social Management Plan (ESMP) for the approval of the Engineer, which must be approved before works can commence.

ii. Within 28 days of Commencement at the latest, the Contractor shall submit a project specific Health and Safety Management Plan (HSMP) for the approval of the Engineer, which must be approved before works can commence.

iii. The requirements of Chapter 2, Section 236, Local Recruitment should be followed, including establishing an office and training programme to favour local recruitment, and support vulnerable people in particular (in coordination with the Employer and local leaders).

The Contractor must provide full time on site during the works the following qualified and experienced staff:

- Environment, Social, Health and Safety Expert (ESHS)
- Community Liaison Expert

Note, this is the minimum and additional staff must also be allocated to these duties, as required, to ensure full compliance with the requirements. In general the Contractor must have experience of implementing works in densely populated, urban areas and it is considered that full compliance with all requirements is included in the Contractor's offer.

Specific items are including in the BoQ for compliance with the Environmental, Social and Health and Safety standards.

2201. MANAGEMENT PLAN PRINCIPLES

This project is geared towards enhancing social and economic benefits to the people living in the project area. It is essential that the project should also observe environmental protection requirements in accordance with the established laws and regulations to ensure sustainability. To realize this goal, acceptability by a majority of the beneficiaries and minimal effects to the physical environment will require to be integrated in the project through constant consultations, evaluations

and review of the design aspects throughout the project coverage. Among the factors that need to be considered in this particular project implementation will include:

- The Contractor shall hire qualified Community Liaison Officers who will be act as an inter-phase between the contractor and community. The Community Liaison Officers will be responsible for continuous engagement of the community.
- Ensure prevention of pollutants discharge into the drainage systems and pollution of public water bodies,
- Enhance integration of environmental, social and economic functions in the project implementation.

2202. SPECIFIC MANAGEMENT ISSUES

Management Responsibilities

The respective ESHS Expert will oversee environment and management aspects during construction of the project.

The contractor shall be required to submit, under due consideration of the ESMMP as part of the ESIA the below listed management plans.

- Occupational health and safety plan
- Traffic management plan
- Public health and safety management plan
- The provisions for the workers grievance mechanism
- Environmental and social monitoring plan (with further detail to the outline of monitoring indicators as presented in the ESMMP) below.

2203. Construction Phase: Environmental and Social Management and Monitoring Plan

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas & Responsibilities	Monitoring Indicator
Seeking approvals from NEMA for ESIA and Approval of plans from County and National Government	Delay in implementation of the project due to objections and stop orders	Low	▪ The Contractor shall ensure that all pertinent permits, certificates and licences have been obtained prior to any activities commencing on site and are strictly enforced/ adhered to; ▪ The Contractor shall maintain a database of all pertinent permits and licences required for the contract as a whole and for pertinent activities for the duration of the contract	All the settlements Responsibility AWSB	• Degree of completion of set of required approvals / permits issued (%), Number and type of findings during any audits based on conditions of approvals
construction campsites *(see also requirement for sub-plans to this ESMMP as described under ESMMP management below*	Environmental degradation risks	Low	▪ Undertake ESIA studies for the target camp sites and obtain approval from the relevant authorities (including NEMA) ▪ Isolate through fencing the camp sites from access by the public for their safety ▪ Preferably to be located on land already cleared land wherever possible ▪ The Contractor's Camp layout shall take into account availability of access for deliveries and services and any future works	Campsites Responsibility Contractor	• Environment licence • Number of public outcry due to accidents
Access to campsites and construction sites *(see also requirement for sub-plans to this ESMMP as described under ESMMP management below*	Environmental degradation risks	Low	▪ Utilize to the extent possible the existing public roads to avoid social and economic disruption ▪ Ensure road safety measures for the construction vehicles to the extent possible by observing all traffic regulations	Access Roads Responsibility Contractor	• Cases of private land required • Accidents occurrence incidences
Environmental Training and Awareness *(see also requirement*	Risks of Environmental degradation risks and occupational health and safety related accidents	High	▪ The Contractor and sub-contractors shall be aware of the environmental requirements and constraints on construction activities contained in the provisions of the EMP	All Workers Responsibility	• Number of Trainings Held • Availability of Training reports

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas & Responsibilities	Monitoring Indicator
for sub-plans to this ESMMP as described under ESMMP management below			▪ The Contractor will be required to provide for the appropriate Environmental Training and Awareness as described in this EMP in his costs and programming ▪ An initial environmental awareness training session shall be held prior to any work commencing on site, with the target audience being all project.	Contractor	• Attendance list of participants during the training sessions
HIV/AIDS awareness and prevention campaign *(see also requirement for sub-plans to this ESMMP as described under ESMMP management below*	Risks of Increased HIV and Aids transmission in the area		▪ The Contractor shall institute HIV/AIDS awareness and prevention campaign amongst his workers for the duration of the contract, contracting an implementing organisation, with preference for an organisation already working on this issue in the project area; ▪ The campaign shall include the training of facilitators within the workers, information posters in more frequented areas in the campsite and public areas, availability of promotional material (T-shirts and caps), availability of condoms (free), and theatre groups	All Workers and selected workshops targeting communities <u>Responsibility</u> Contractor	• Number of Trainings Held • Availability of Training reports • Attendance list of participants during the training sessions
Setting out and clearance of project routes and site	Delay in project implementation due to opposition from PAPs	High	▪ Implementation of Resettlement Action Plan (RAP) recommendations before commencement of civil works ▪ In the event that the contractor requires additional land, the contractor will apply the provisions of the RAP. ▪ if the respective land setting is not reflected in the RAP, to comply with WB OP 4.12; prior to the acquisition of any additional land, the contractor shall submit the respective plan for compensation to the PEA and this plan has to be approved by the relevant authorities as well as by the PEA.	All the settlements <u>Responsibility</u> AWSB – Implement RAP Contractor – extra compensation on site	• Numbers of satisfied PAPS • Extend of route opened to the contractor
Local Labour / Employment *(see also requirement for sub-plans to this ESMMP as described*	Delay in project implementation due to opposition from aggrieved community members	High	▪ Wherever possible, the Contractor shall use local labour, and women must be encouraged to be involved in construction work ▪ The contractor shall ensure compliance to the gender balance as required by the 2/3 gender rule ▪ Comply with IFC PS 2 on labour and Working Conditions including ILO conventions on Labour	All the settlements <u>Responsibility</u> Contractor	• Number of workforce employed from the local community • Number of females employed • Complaints from disgruntled work force

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas & Responsibilities	Monitoring Indicator
under ESMMP management below			and Working Condition described in section 7 of the Report.		
ESMP management records *(see also requirement for sub-plans to this ESMMP as described under ESMMP management below*	Risks of non-conforming to ISO 9001 on QMS and ISO 14001 on EMS	Medium	▪ The updated version of the EMP should be kept on site ▪ Copies of all necessary permits and licences should be kept on site ▪ All site specific plans prepared as part of the updated EMP ▪ All related Environmental, Social, Health and Safety Management registers and correspondence, including any complaints ▪ A register of audit non-conformance reports and corrective actions	All the settlements <u>Responsibility</u> Contractor	• Number of available permits on site • ISO audit report on non-conformities • Number of corrective measure adopted
Stakeholder Engagement *(see also requirement for sub-plans to this ESMMP as described under ESMMP management below*	Risk of delays in Project Implementation due to disputes / grievances from Stakeholders	High	▪ Contractor to hire community liaison officers who will act as a link between the community and contractor ▪ Identification and Engagement of all Stakeholders to be undertaken ▪ A working Grievance Redress Mechanism to be established before commencement of Works. ▪ This is as guided by KfW Sustainability Guidelines 2016, World Bank Environment and Social Standard 10 (Draft)	All work areas <u>Responsibility</u> AWSB and Contractor	• No. of Complaints recorded in the Grievances Book • Number of community liaison officers employed by the contractor
Earth moving and excavations (channeling and site preparations) *(see requirement for sub-plans to this ESMMP as described under ESMMP*	▪ Safety risks ▪ Air pollution ▪ Social nuisance	Medium	▪ Provide notices, signage and information to the public for their safety at all locations ▪ Install barriers along walkways, crossings and public places affected by the works for public safety ▪ Where there are potential for nuisance from dust generation, ensure earth moving is under dump conditions (consider watering where necessary) ▪ Inform immediate communities or stakeholders of the activities	All work areas <u>Responsibility</u> Contractor	• Accidents occurrence incidences • Cases of respiratory complication at nearby health centre

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas & Responsibilities	Monitoring Indicator
management above)	▪ Vegetation Cover destruction	Low	▪ Construction activities will be limited to project sites / routes which already exist therefore limited destruction to vegetation cover	All work areas <u>Responsibility</u> Contractor	• Soil erosion extend and intensity on site
	▪ loss of top soil	Low	▪ Stock piling of top soil, construction material and wastes should be done only at designated sites approved by the supervising engineer, erosion prevention through berming of loose soil sites should be done in all areas susceptible to agents of erosion.	All work areas <u>Responsibility</u> Contractor	• Soil erosion extend and intensity on site
	▪ Public safety risks ▪ Worker Occupational safety risks	Medium	▪ Notify public the intent to cut sections of the road for safety precautions ▪ Provide signage and safety information in all work areas. ▪ Ensure compliance by workers with safety safeguards including the OHS, provision of safety gear and enforcement of application	civil works areas Responsibility Contractor Supervision Team	• Accidents occurrence incidences
	Disruption of amenities (access roads, services lines and driveways) causing inconveniences to the community	Medium	▪ Notify other services providers and ▪ Open small sections that can be reinstated within the shortest period to avoid public disruption ▪ Mark the lines to avoid conflicts with other activities	civil works areas <u>Responsibility</u> Contractor Supervision Team	• Number of complaints from community due to lack of certain services
Materials sourcing, from borrow pits and quarries delivery and storage *(see requirement for sub-plans to this ESMMP as described under ESMMP management*	Environmental and Safety risks associated with burrowing and opening up of new quarry sites	High	▪ The Contractor will be responsible for ensuring that appropriate authorisation to use the proposed borrows pits and quarries has been obtained before commencing activities ▪ Topsoil shall be stripped prior to removal of borrow and stock piled onsite. This soil shall be replaced on the disturbed areas once the operation of the borrow site or quarry is complete ▪ Construction material sources should be environmentally sustainable (approved accordingly) ▪ Delivery routes and modes of transport should be approved	Burrow Pits and Quarry Site <u>Responsibility</u> Contractor Supervision Team	• Environmental Status of reinstated burrow pits • Complains from the community on burrow pits and material transportation

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas & Responsibilities	Monitoring Indicator
above)			Material storage on site not to be internal or external nuisance		
Concrete / cement batching plant *(see requirement for sub-plans to this ESMMP as described under ESMMP management above)*	Risks associated with water resource pollution and air pollution from dust this could lead to respiratory problems		▪ Where required, a Concrete batching plant shall be located more than 20m from the nearest stream/river channel; ▪ Top soil shall be removed from the batching plant site and stockpiled ▪ Contaminated storm water and wastewater runoff from the batching area and aggregate stock piles shall not be permitted to enter streams but shall be led to a pit where the water can soak away ▪ Suitable screening and containment shall be in place to prevent windblown contamination associated with any bulk cement silos, loading and batching ▪ Cleaning of equipment and flushing of mixers shall not result in pollution of the surroundingenvironment	Concrete / cement batching plant <u>Responsibility</u> Contractor Supervision Team	• Number of incidence of Environment pollution around the plant
Wastes removals and disposal *(see requirement for sub-plans to this ESMMP as described under ESMMP management above)*	Risks of contaminating surface and underground water resources	High	▪ Construction wastes (residual earth, debris and scrap materials) to be removed for safe disposal ▪ Encourage recycling where possible (concrete debris for access road surfacing), ▪ Contaminated organic matter in the work areas to be isolated for safe disposal ▪ Material residuals to be disposed off in accordance with established regulations	Construction areas <u>Responsibility</u> Contractor Supervision Team	• Number of complaints from community not happy with waste management of the contractor
Spoil Storage site *(see requirement for sub-plans to this ESMMP as described under ESMMP management above)*	Risks of solid waste mismanagement leading to pollution	Medium	▪ Preferably to be located on land already cleared wherever possible. Communities shall be involved in the site location to avoid conflict ▪ The need to be more than 20 meters from water courses and in apposition that will facilitate the prevention of storm-water runoff from the site from entering the watercourse ▪ Contouring of spoil site to approximate natural topography and drainage and/or reduce erosion	Construction areas <u>Responsibility</u> Contractor	• Number of complaints from community not happy with waste management of spoil material

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas & Responsibilities	Monitoring Indicator
			impacts on the site ▪ The Contractor shall ensure that the placement of spoil is done in such a manner to minimise the spread of materials and the impact on surrounding vegetation and that no materials' creep' into' no-go' areas	Supervision Team	
Occupational Health and Safety *(see requirement for sub-plans to this ESMMP as described under ESMMP management above)*	Risks of Accidents, Injuries or death of workers or community member	High	▪ Provide construction workers with personal protective gear (gloves, gum boots, overalls and helmets), ▪ Provide temporary toilets and bathrooms for the construction workers at the work sites. The contractor must provide modern eco-mobile toilets, from a company approved by NEMA for use by the workforce at different points while on site. ▪ Provide onsite first aid kit accessible by the workers on need, ▪ Isolate the site for access by the local communities during the construction for their safety and health ▪ Contractor to provide a Healthy and Safety Plan prior to the commencement of works to be approved by the resident engineer. ▪ Contractor to follow provisions of Kenya Occupational Health and Safety Act 2007 ▪ Contractor to follow provisions of The World Bank Group Environment Health and Safety General Guidelines and specific Guidelines on Water and Sanitation and the World Bank Environmental and Social Standard No. 4 on Community Health and Safety (Draft)	All work areas <u>Responsibility</u> Contractor Supervision Team	Accidents occurrence incidences recorded in the Incidence Book
Storage of fuel oils, lubricants, chemicals and flammable materials *(see requirement for sub-plans to this ESMMP as described*	Hazards of fire outbreak, oil and chemical spills.	High	▪ Follow specifications of the Occupational Health and Safety Act, EMCA 1999 and others in the development and operation of stores.	All work areas <u>Responsibility</u> Contractor Supervision Team	Incidence of reported cases of fuel leaks and fire incidences

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas & Responsibilities	Monitoring Indicator
under ESMMP management above)					
Sanitation issues resulting from both solid and liquid wastes on site. *(see requirement for sub-plans to this ESMMP as described under ESMMP management above)*	Risks associated with water born diseases exposed to community and workforce	Medium	▪ The Contractor shall comply with all laws and any by-laws relating to public health and sanitation ▪ Sufficient temporary/ portable toilets or pit latrines shall be provided for the workers, secured to the ground to the satisfaction of the RE to prevent them from toppling over ▪ A wash basin with adequate clean water and soap shall be provided alongside each toilet .Staff shall be encouraged to wash their hands after use of the toilet, in order to minimise the spread of possible disease	All work areas Responsibility Contractor Supervision Team	Incidence of reported cases of water related diseases among the workforce and neighbor community
Noise and Vibration control from plant and equipment *(see requirement for sub-plans to this ESMMP as described under ESMMP management above)*	Risk to health and safety of community and workers	Medium	▪ The Contractor shall keep noise level within acceptable limits 55dB (A) at day time and 35dB(A) at night and construction activities shall, where possible, be confined to normal working hours in the residential areas ▪ Hospitals and other noise sensitive areas shall be notified by the Contractor at least 5days before construction is due to commence in their vicinity ▪ Any complaints received by the Contractor regarding noise will be recorded and communicated to the Resident Engineer (RE)	.Civil works areas and access roads Responsibility Contractor Supervision Team	Reported complaints from neighbor community and institutions
Traffic management on site *(see requirement for sub-plans to this ESMMP as described*	Risks of Accidents, Injuries or death of workers or community member	high	▪ Strict use of warning signage and tapes where the trenches are open and active sites ▪ Employ and train road safety Marshalls who will be responsible for management of traffic on site ▪ Contractor to provide a traffic management plan during construction to be approved by the resident engineer	Civil works areas and access roads Responsibility Contractor Supervision Team	Accidents occurrence incidences

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas & Responsibilities	Monitoring Indicator
under ESMMP management above)					
Air Quality Control *(see requirement for sub-plans to this ESMMP as described under ESMMP management above)*	Air pollution causing respiratory disorders to human	High	▪ Workers shall be trained on management of air pollution from vehicles and machinery. All construction machinery shall be maintained and serviced in accordance with the contractor's specifications ▪ The removal of vegetation shall be avoided until such time as clearance is required and exposed surfaces shall be re-vegetated or stabilised as soon as practically possible ▪ The contractor shall not carry out dust generating activities (excavation, handling and transport of soils) during times of strong winds ▪ Vehicles delivering soil materials shall be covered to reduce spills and wind blown dust ▪ Water sprays shall be used on all earthworks areas within 200 metres of human settlement.	All work areas <u>Responsibility</u> Contractor Supervision Team	Cases of respiratory complication at nearby health centre
Contractor de-mobilization and site reinstatement *(see requirement for sub-plans to this ESMMP as described under ESMMP management above)*	Associated risks of environmental degradation	High	▪ The site is to be cleared of all construction materials, including litter prior to hand over ▪ Fences, barriers and demarcations associated with the construction phase must be removed from the site ▪ Fences, barriers and demarcations associated with the construction phase must be removed from the site ▪ Rehabilitation Activities of Environmental Cases identified must continue throughout the defect liability period	All work areas <u>Responsibility</u> Contractor Supervision Team	Closeout audit report findings

SECTION 2

STANDARD REFERENCE NUMBERS

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1. Introduction

The Engineer has agreed to use a method of modifying the text of Engineering specifications by referring to a Standard Specification Reference Number (SRN) instead of a National Standard and then providing a tabulated comparison between British and German Standards, cross-referenced further where appropriate to an International Standard (ISO), an International Electro-technical Standard (IEC), to an American Waterworks Standard (AWWA) or other appropriate National Standards.

2. General Clause on Standard Specification

A general introductory clause to be inserted into general specification documents has been prepared. It is quoted below to assist in the preparation of Future Specification Volumes.

Standards

The Contractor shall observe these Specifications and shall carry out all work in a skilled and workmanlike manner in keeping with modern methods of mechanical and construction Engineering.

In addition, the Contractor shall conform with all conditions currently in force with regard to the execution of construction work and shall follow all instructions issued by the competent Authorities, the Employer and the Engineer.

Where Standard Specifications are referred to in the Text of the Specifications this is done by reference to a Standard Specification Reference Number (SRN). A table of comparison is annexed to this Specification where the SRN is cross-referenced to Standard Specifications issued by the International Standards Organization (ISO) and to National Standard Specification that will be accepted in their English version by the Engineer as providing for the quality of workmanship etc. required.

The Bidder shall at his discretion base his Bid on one or other of the National Standard Specifications indicated in that table save that where a relevant Standard Specification issued by the ISO exists at the date of Bid, such an International Standard should as a minimum be compiled with. As the National Standards referred to in the table of comparison may expand on or strengthen further the requirements of ISO, Bidders choosing not to comply with one of the National Standards indicated may either indicate an alternative National Standard with which they shall comply or provide with their Bid a full and detailed description of the Standards they propose to attain.

Where a Bidder offers a particular item to a National Standard not specified in the table of comparison he shall comply with the requirements of the Instructions to Bidders in this respect and shall enclose a copy in English of the alternative National Standard offered with his Bid. Alternative National Standards or Bidder's own detailed description of the Standards they propose shall be subject to the approval of the Engineer.

3. List of National Specification Cross Referenced

The list has been sub-divided into sections as follows: -

SRN No.	Specification
001-099	Electrical and Mechanical
100-199	Concrete
200-299	Metallic Pipes and Fittings
300-399	Plastic Pipes and Fittings
400-499	Other Pipes and Fittings
500-599	Valve, Meters, Hydrants and Other Specials
600-649	Testing Methods and Equipment
650-699	Site Work Codes of Practice
700-749	Drawing Practice, Standard Symbols, etc.
750-799	Glossary
800-899	Building Materials (exclu. In-situ Concrete)
900-999	Miscellaneous

3.1 CONCRETE

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
100	METHOD FOR SPECIFYING CONCRETE	1045	TBL. 1	5328	TBL. 3	KS 02-594	
101	STANDARD OF MATERIAL & WORK - GENERAL	See	VOB	8110		VOB 2	
102	STANDARDS OF MATERIAL, WATER RETAINING STRUCTURES		SUB. NO.	8007			
103	ORDINARY PORTLAND CEMENT	1164	1	12		KS 02-1262 & KS 02-1263	
104	SULPHATE RESISTANT CEMENT	1164	1;CL. 4	4027			
105	MORTAR CUBES - COMPRESSIVE STRENGTH	1164	1;CL. 4-4	12	METHOD 2 CL.7.3	ISO 3893	
106	CEMENT - TEST FOR SOUNDNESS		6, EN.112	12	CL.9		
107	SAMPLING AND TESTING OF AGGREGATES	4226	1-4	812	1, 2, 3	BS EN 1097-3 BS EN 932-1	BS 812 Part 1 Replaced by BS 882 Part 2 Replaced by BS EN 1097-3 Part 102 Replaced by BS EN 932-1 but remains current
107	SAMPLING AND TESTING OF AGGREGATES (CONT.)	1045		812	101-119		
108	FINE AGGREGATE FOR CONCRETE - GENERAL	4226	1-4	882	CL.4.1		
108	FINE AGGREGATE FOR CONCRETE - GENERAL (CONT.)	1045					
109	FINE AGGREGATE FOR CONCRETE - GRADING	4226	1-4	882	TBL.2		
110	COARSE AGGREGATES FOR CONCRETE - GENERAL	4226		882	CL.4.1		
110	COARSE AGGREGATES FOR CONCRETE - GENERAL (CONT.)	1045					
111	COARSE AGGREGATES FOR CONCRETE - GRADING	4226		882	TBL.2		
111	COARSE AGGREGATES FOR CONCRETE - GRADING (CONT.)	1045					
112	COARSE AGGREGATES FOR CONCRETE - SHRINKAGE & ABSORPTION	4226		812	2	ISO 6783 BS EN 1367	BS 812 Part 120 Replaced by BS EN 1367 but remains current
112	COARSE AGGREGATES FOR CONCRETE - SHRINKAGE & ABSORPTION (CONT.)	1045					
113	COARSE AGGREGATES FOR CONCRETE - FLAKINESS	4226		812	105.1		
113	COARSE AGGREGATES FOR CONCRETE - FLAKINESS (CONT.)	1045					
114	WATER FOR MAKING CONCRETE	4226		3148			
114	WATER FOR MAKING CONCRETE (CONT. 1)	4030					
114	WATER FOR MAKING CONCRETE (CONT. 2)						
115	CONCRETE MIX DESIGN - GENERAL			5328			
115	CONCRETE MIX DESIGN - GENERAL (CONT.)	1084	1				
116	TRIAL MIXES - CUBES	1048		1881	108		
117	SAMPLING & TESTING OF CONCRETE	1048		1881	5, 114, 121, 122	ISO 1920, 4012, 4108, 4013	
118	CONCRETE BATCH MIXER			1305			BS 1305 Obsolescent
119	CONCRETE BATCH TYPE MIXERS	459		3963			BS 3963 Obsolescent
120	STRUCTURAL USE OF R/C IN BUILDING	1045		8110	1		
121	CONCRETE TRUCK-MOUNTED MIXERS	1084	3	4251	Withdrawn		BS 4251 Withdrawn
122	BITUMEN RUBBER JOINT SEALING COMPOUND			2499	TYPE A1		
123	POLYSULPHIDE JOINT SEALING COMPOUND			4254			BS 4254 Obsolescent
124	WATERPROOF BUILDING PAPERS			1521	(CLASS B)		
125	IMPACT TESTING OF MILD STEEL	488	3	7613 7668	Grade NDI, CL.B		BS 4360 Withdrawn. Replaced by BS 7613, BS 7668, BS EN 10029 Parts 1 to 3 of BS EN 10113, BS EN 10155, BS EN 10210-1
126	STEEL R/F HOT-ROLLED STEEL BARS	488	1-3	4449			
127	STEEL R/F COLD TWISTED	488	1-3	4449			
128	STEEL R/F STEEL FABRIC	488	4-5	4483			
129	BAR REINFORCEMENT AND BENDING			4466			
130	SAND FOR INTERNAL PLASTERING	4226		1199			
131	PLYWOOD SHUTTERING	68791		6566	1-8		BS 6566 Withdrawn. Replaced by various BS EN standards on the same subject
131	PLYWOOD SHUTTERING (CONT.)	68792					
132	CONCRETE COMPACTION	4235	1,2				
133	CONCRETE - SITE QUALITY CONTROL	1084	1				
134	DESIGN OF CONCRETE MIXES	52171		See HMSO		HMSO RD NOTE 4	
135	SAND FOR MORTAR	4226		1200			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
136	SAND FOR RENDERING	4226		1199			
137	HOT APPLIED JOINT SEALER			2499			
138	WATER STOPS AND WATER BARS	7865	1, 2	8007			
139	TESTING CONCRETE STATIC MODULES (COMPARISON ELASTICITY)			1881	121		
140	TESTING CONCRETE - WATER ABSORPTION			1881	122		
141	TESTING CON-SAMPLING, TESTING FRESH CONCRETE, ETC.	1048		1881	101-110 & 113	KS 02-595 : 1-8	
142	PRECAST CONCRETE COMPONENTS (COPING UNITS)			5642/2	2		
143	STRUCTURAL USE OF CONCRETE DESIGN & CONSTRUCTION			8110	1		
144	STRUCTURAL USE OF CONCRETE - SPECIAL CIRC.						
145	IN-SITU CONCRETE DIAPHRAGM WALLS	4126					
146	TEST SIEVES FOR AGGREGATES			410			
147	LIGHT WEIGHT AGGREGATES FOR CONCRETE	4226	2, 3	3797	2		BS 3797 Partly Replaced by BS EN 1744-1: 1998
148	SUPERSULPHATED CEMENT			4248 (4550)			BS 4248 Partly Replaced by Parts and Section of BS 4550
149	CONCRETE ADMIXTURES			5075			
150	GRADUATE MEASURING CYLINDER			604		ISO 4788	
151	COLD REDUCED STEEL WIRE FOR THE REINFORCEMENT OF CONCRETE			4482			
152	FUSION BONDED EPOXY COATED CARBON STEEL BARS FOR THE REINFORCEMENT OF CONCRETE			7295	1 & 2		Part 1: Coated bars Part 2: Coatings

3.2 METALLIC PIPES AND FITTINGS

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
200	GREYCAST IRON PRESSURE PIPES AND FITTINGS			1211		ISO 13; ISO 49	BS 1211 Obsolescent Partially replaced by BS 4772
200	GREY IRON PIPES AND FITTINGS (CONT)			4622		ISO 13	BS 4622 Obsolescent
201	CAST IRON FLANGED PIPES & FITTINGS			2035		ASME/ANSI B16.1 - 1998	BS 2035 Obsolescent Partially replaced by BS 4772
202	DUCTILE IRON PIPES & FITTINGS (WATER)					ISO 2531, EN 545	
202	DUCTILE IRON PIPES & FITTINGS (SEWERAGE)					EN 598	
202	DUCTILE IRON PIPES & FITTINGS (GAS)					EN 969	
203	STEEL TUBES WITH PLAIN OR THREADED ENDS			1387		ISO 65	
203	STEEL TUBES WITH THREADED ENDS (CONT)	2440					
203	STEEL TUBES WITH THREADED ENDS)CONT)	2441					
203	STEEL TUBES WITH THREADED ENDS (CONT)	2442					
203	STEEL TUBES WITH THREADED ENDS-THREADS	76	2	21		ISO 7/1:1982; ISO 7/2:1982	
204	WROUGHT STEEL PIPE FITTINGS TO SSRN 203			1740	1	ISO 4145	
204	TH. STEEL PIPE FITTINGS TO SSRN 203	2980					
204	TH. STEEL PIPE FITTINGS TO SSRN 203-LONG THREAD	2981					
204	TH. STEEL PIPE FITTINGS TO SSRN 203-NIPPLES	2982					
204	TH. STEEL PIPE FITTINGS TO SSRN 203-BENDS	2983					
204	TH. STEEL PIPE FITTINGS TO SSRN 203-TEES ETC.	2987	1, 2				
204	W. STEEL PIPE FITT. TO SSRN 203-BUSHINGS	2990					
204	W. STEEL PIPE FITT. TO SSRN 203-PLUGS & CAPS	2991					
204	TH. STEEL PIPE FITTINGS TO SSRN 203-SOCKETS	2986				ISO 7-2:1982	
204	W. STEEL PIPE FITT. TO SSRN 203-RED'NG SOCKETS	2988					
205	COPPER TUBES FOR WATER					EN 1057, ISO 8493 (TESTS)	
205	COPPER TUBES FOR WATER (CONT)	1754	3				
205	COPPER TUBES FOR WATER (CONT)	1755	3				
206	COPPER TUBES - GENERAL PURPOSE			2871	2	ISO 196:1978	
206	COPPER TUBES - GENERAL PURPOSE (CONT)	1754	1,2				
206	COPPER TUBES - GENERAL PURPOSE (CONT)	1755	1,2				
207	FLANGES FOR FERROUS PIPES - STEEL BY PN	2500		4504	3-3.1	ISO 7005-1:1992	BS 4504 Part 3: Sections 3.2 (1989) Withdrawn. Replaced by BS EN 1092-2 (1997)
207	FLANGES FOR FERROUS PIPES - STEEL BY CLASS	2501	1	1560	3-3.1	ISO 7005:1988; ANSI B 16.5	
207	FLANGES FOR FERROUS PIPES - C.I. BY CLASS	2519	1	1560	3-3.2	ISO 7005-2	
207	FLANGES FOR FERROUS PIPES - C.I. BY PN				2	EN 1092, ISO 2531:1991; ISO 7005-2:1988	
207	FLANGES FOR FERROUS PIPES-SLIP ON FOR WELDING	2576					
207	FLANGES FOR FERROUS PIPES-WELDING NECK	2627-38					
207	FLANGES FOR FERROUS PIPES-SCREWED	2566					
207	FLANGES FOR FERROUS PIPES-LAPPED-PLAIN COLLAR	2655-56					
207	FLANGES FOR FERROUS PIPES-LOOSE-WELDING NECK	2673					
207	FLANGES FOR FERROUS PIPES-CONTACT SURFACE	2526					
207	FLANGES FOR FERROUS PIPES-BLANK	2527					

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
208	GASKET DIMENSIONS TO SSRN 207 (a) & (d)				1	EN 1514	
208	GASKET DIMENSIONS TO SSRN 207 (a) & (d) (CONT)				2	EN 1514	
208	GASKET DIMENSIONS TO SSRN 207 (a) & (d) (CONT)				3	EN 1514	
208	GASKET DIMENSIONS TO SSRN 207 (a) & (d) (CONT)				4	EN 1514	
208	GASKETS-FOR GROOVED FLANGES	2693					
208	GASKETS-GROOVED O-RINGS	2697					
209	C.I. PIPE FITTINGS, MALLEABLE, SCREWED					ISO 49:1994	
210	STEEL PIPES & FITTINGS - GENERAL			534			
210	STEEL PIPES - WATER-GENERAL	2460		534		EN 10224, AWWA C200-97, NFA 49-150 JIS G 3460-88	
210	STEEL PIPES & FITTINGS - DESIGN	2413	1, 2	8010 2.1		AWWA M11	
210	STEEL PIPES & FITTINGS - WELDING JOINTS	2559	1, 2, 3	8010 2.1		AWWA M11 ASTM A333/A333M-99	
211	CEMENT MORTAR LINING - D.I. PIPES			EN 545		EN 545, AWWA C.104A, C602-95	
211	CEMENT MORTAR LINING - D.I. PIPES	2614					
211	CEMENT MORTAR LINING - D.I. PIPES (CONT)					DVGW W343 ISO 4179:1985, ISO 6600:1980,	
212	CEMENT MORTAR LINING - STEEL PIPES	2614		534		AWWA C 205, NFA 49-701DVGW-W343/W346	
212	CEMENT MORTAR LINING - STEEL PIPES (CONT)	2614				AWWA C 602-95 ISO / DIS 8324	
213	S. PIPES & TUBES-MATERIAL, PROP., TESTS	1629		3600		AWWA C200-97	
213	CARBON STEEL PIPES AND TUBES			3601		ISO 2604/2 /3 /6	
213	STEEL PIPES AND TUBES-SPECIAL REQUIREMENTS	1626					
213	STEEL PIPES AND TUBES-SEAMLESS	2448					
213	STEEL PIPES AND TUBES-WELDED	2458					
214	BITUMEN PROTECTION TO IRON AND STEEL - HOT			4147		(BS 4147 type I, grade 'd')	
214	BITUMEN PROTECTION TO IRON AND STEEL- COLD			3416		(BS 3416 type II)	
214	BITUMEN PROTECTION TO STEEL PIPES ETC.	30673	Type E4				
214	BITUMEN PROTECTION TO DUCTILE IRON PIPES	30674	4				
215	EXT. PROTECTION - IRON & STEEL-EPOXY C.			none		AWWA C210-97	
216	STEEL FITTINGS - REINFORCING			none		AWWA C208-59 AWWA M11	
216	STEEL FITTINGS - DIMENSIONS			534		AWWA C208-59 AWWA M11	
217	D.I. PIPES & FITT.-SCREWED GLAND JOINTS					See SSRN 219	
218	D.I. PIPES & FITT.-BOLTED GLAND JOINTS					See SSRN 219	
219	D.I. PIPES & FITT.-S & S JOINTS			8010	2-2.1		
219	D.I. PIPES & FITT.-S & S JOINTS (CONT)					EN 545	
219	D.I. PIPES & FITT.-S & S JOINTS (CONT)	28603					
219	PIPELINES ON LAND; DESIGN, CONSTRUCTION AND INSTALLATION: STEEL FOR OIL AND GAS			8010	2.8		
220	D.I. PIPES-ZINC COATING & PROT. SHEATHS	30674	3	none			
221	IRON AND STEEL PIPES-ENAMEL-HOT APPLIED			7873		AWWA C203-97	
221	STEEL FLANGED PIPES & FITTINGS-ENAMELLED	2873					
222	ELASTOMERIC JOINTS RINGS-REQUIREMENTS			2494			Partly replaced by BS 7874 and BS EN 681-1
222	ELASTOMERIC JOINTS RINGS-VULCANISED RUBBER				1	EN 681	

222	ELASTOMERIC JOINTS RINGS-DRAINS & SEWERS	4060					
223	PIPE THREADS-TUBES & FITT. (WATERTIGHT	See ISO DIN		21		ISO 7/1:1982; ISO 7/2:1982	

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
224	CAST IRON S & S PIPES AND FITTINGS			78	2		BS 78 Withdrawn, Replaced by BS 4622 Part 2 Obsolescent, Partially replaced by BS 4772
225	STEEL PIPES-HOT DIP GALVANISING					EN 10240	
226	CARBON STEEL FITTINGS - BUTT-WELDING-GENERAL	2609		1965	1		BS 1965 Part 2 Withdrawn
226	STEEL FITTINGS - BUTT-WELDING-TEES	2615	1, 2				
226	STEEL FITTINGS - BUTT-WELDING-REDUCERS	2616	1, 2				
226	STEEL FITTINGS - BUTT-WELDING-CAPS	2617					
227	POLYTHENE SLEEVING FOR STEEL PIPES & FITTINGS	none		none		ISO 8180:1985	
227	POLYTHENE SLEEVING FOR D. I. PIPES	30674	5				
228	ST. PIPES-DIMENSION & MASSES-PRESS. PURPOSE	2413	1, 2	3600			
228	S. PIPES-DIMENSION & MASSES-PRESS. (CONT)	2460					
229	STAINLESS STEEL TUBES AND WIRES			1554			
229	STAINLESS STEEL TUBES AND WIRES (CONT)			4825	1	ISO 2037:1980	
229	STAINLESS STEEL TUBES AND WIRES (CONT)			6362		ISO 7598	
229	STAINLESS STEEL TUBES AND WIRES (CONT)	17457					
229	STAINLESS STEEL TUBES AND WIRES (CONT)	17440					
230	STEEL PIPES FOR WATER FLEXIBLE SOCKET & SPIGOT JOINTS	2460		CP2010-2		EN 10224, ISO 559	
230	STEEL PIPES FOR WATER FLEXIBLE SOCKET & SPIGOT JOINTS	2460		CP2010-2		EN 10224, AWWA C200-97	
231	FERROUS P. DEFINITION OF NOMINAL PRESSURE			none		ISO 7268:1983	
232	STEEL PIPELINES - TAPE COATING SYSTEMS	30672	1	none		AWWA C214-95	
233	BURSTING DISCS & DEVICES			2915		ISO 6718:1991	
234	STEEL PIPES FOR PETROLUEM AND GAS INDUSTRY	17172				EN 10208-2, API 5L	
235	FITTINGS TO STAINLESS STEEL TUBES			4825	2	ISO 2851:1973	
235	FITTINGS TO STAINLESS STEEL TUBES (CONT)			4825	3	ISO 2852:1974	
235	FITTINGS TO STAINLESS STEEL TUBES (CONT)			4825	4	ISO 2853:1976	
235	FITTINGS TO STAINLESS STEEL TUBES (CONT)			4825	5		
236	FITTINGS TO BRASS TUBES			2051	1		
237	RUBBER GASKET MATERIAL JOINTS FOR PIPELINES			2494		ISO 4633; ISO 6447; ISO 6448	
238	STORAGE OF VULCANISED RUBBER			none		ISO 2230:1973	
239	BITUMINOUS VARNISH TO DUCTILE IRON PIPES			none		ISO 8179-2:1995	
240	FOUNDING - SPHEROIDAL GRAPHITE CAST IRON					EN 1563	
240	FOUNDING - AUSTEMPERED DUCTILE IRON CASTINGS					EN 1564	
241	FUSION BONDED EPOXY COATINGS FOR STEEL PIPES	30671		none		EN 10309, AWWA C213, NFA 49-706	
241	FUSION BONDED EPOXY LININGS FOR STEEL PIPES					AWWA C213	
242	FLEXIBLE BOLTED SLEEVE COUPLINGS			534		AWWA C219	
243	FLEXIBLE GROOVED AND SHOULDERED COUPLINGS					AWWA C606	
244	SPHERICAL JOINTS FOR WELDING, STEEL PIPES			534		UNI 6363	
245	BIT. SEAL COAT'GS ON D.I. PIPE CEM. MOR. LINING			7892			
246	POLYMERIC FILM PROT. SLEEV'G FOR IRON PIPES	30674	5	6076		EN 534	

247	HOT ENAMEL COATING TO IRON & STEEL PIPES			7873			
248	EXTERNAL ZINC COATINGS ON DI PIPES	2444		none		ISO 8179-1:1995	
249	BOLTS & NUTS FOR PIPELINES	2507		none			

250	STEEL PIPELINES - THERMOSET PLASTIC COATINGS	30671		BGC/CW6		AWWA C213, NFA 49-706	
SRN	**SUBJECT**	**DIN**	**PART**	**BSS**	**PART**	**OTHER**	**REMARKS**
251	STEEL PIPES - POLYPROPYLENE COATING	30678		none		EN 10286, NFA 49-711	
252	STEEL TUBES - ELECTROMAGNETIC TESTING - LEAKS				1	EN 10246	
253	TWO & THREE LAYER POLYTHENE COATINGS FOR STEEL PIPES	30670		534		AWWA C215, NFA 49-704, NFA 49-710	
254	LIQUID EPOXY COATINGS FOR STEEL PIPES					AWWA C210	
255	LIQUID EPOXY LININGS FOR STEEL PIPES					AWWA C210, NFA 49-709	
256	LIQUID POLYURETHANE COATINGS FOR STEEL PIPES	30671				AWWA C222	
257	LIQUID POLYURETHANE LININGS FOR STEEL PIPES					AWWA C222, NFA 49-709	
258	EXTRUDED POLYTHENE COATINGS FOR D.I. PIPES	30674	1	EN 545		EN 545	
259	CEMENT MORTAR COATINGS FOR D.I. PIPES	30674	2				
260	LIQUID EPOXY COATINGS FOR D.I. PIPES			EN 545		EN 545	
261	FUSION BONDED EPOXY COATINGS & LININGS FOR D.I. FITTINGS					AWWA C116	
262	LIQUID POLYURETHANE COATINGS FOR D.I. PIPES			EN 545		EN 545	
263	LIQUID POLYURETHANE LININGS FOR D.I. PIPES			EN 545		EN 545	
264	TWO LAYER EPOXY-NYLON COATINGS & LININGS FOR STEEL PIPES					EN 10310, AWWA C224	

3.3 PLASTIC PIPES AND FITTINGS

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
300	uPVC PIPES FOR COLD WATER	19532		3505		ISO 2505, 3114, 3606	
300	uPVC PIPES FOR COLD WATER (CONT. 1)	8062				ISO 3472, 3472, 3473, 3474	
300	uPVC PIPES FOR COLD WATER (CONT. 2)					ISO 161/1	
300	uPVC PIPES FOR COLD WATER (CONT. 3)					KEBS 06-149:2	
301	JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES	8063	1, 12	4346	1-3	ISO 2035, 2044	
301	JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES (CONT. 1)	16450				ISO 2045, 2048, 2536	
301	JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES (CONT. 2)	16451					
302	uPVC PIPELINES - LAYING AND JOINTING	16928		See CP		CP 312	
303	uPVC PIPELINES - PRESSURE TESTING	4279	1, 7				
304	uPVC PIPELINES - ADHESIVES FOR JOINTING	16970					
305	uPVC PIPES - GENERAL	8061		3505			
305	uPVC PIPES - GENERAL (CONT. 1)	8062		3506			
305	uPVC PIPES - GENERAL (CONT. 2)	19532					
306	uPVC PIPES - PRESSURE TESTS TO DESTRUCTION			4728		ISO 1167	Obsolescent (but still remains current) Replaced by BS EN 921 and partially replaced by BS EN 2782 Part II method 1127P - 1997 but remains current
307	HDPE PIPES, JOINTS, FITTINGS	16963	1-3	3284 (6572) (6730)			Obsolescent - Partially replaced by BS 6572, BS 6730
308	RUBBER RINGS FOR MECHANICAL JOINTS			2494			
309	uPVC UNDERGROUND DRAIN PIPES & FITTINGS			4660			Partially replaced by BS EN 1401-1
310	uPVC PIPES IMPACT TEST 20 DEGREES CENTIGRADE			3505		ISO 3127	
311	uPVC PIPES SHORT TERM HYDROSTATIC TEST			3505			
312	uPVC PIPES LONG TERM HYDROSTATIC TEST			3505			
313	uPVC PIPES INTERNAL PRESSURE ENDURANCE TEST	8061					
314	uPVC WATER ABSORPTION TEST	8061				ISO 2508	
315	uPVC PIPES - VARIOUS OTHER TESTS					ISO 2505, 3114, 3472, 3473, 3474	
316	PIPES - RATE OF LEAKAGE			8010:2			
317	G.R.P. PIPES			6464			
318	PLASTICS PIPES AND FITTINGS FOR USE AS SUB SOIL FIELD DRAINS			4962			
318	POLYPROPYLENE WASTE PIPE AND FITTINGS (EXTERNAL DIAMETER 34.6MM, 41.0MM AND 54.1MM)			5254			
319	THERMOPLASTICS WASTE PIPE AND FITTINGS			5255			
320	GLASS REINFORCED PLASTICS (GRP) PIPES, JOINTS AND FITTINGS FOR USE FOR WATER SUPPLY OR SEWERAGE			5480			
321	UNPLASTICIZED PVC PIPE AND FITTINGS FOR GRAVITY SEWERS			5481			
322	PLASTICS PIPEWORK (THERMOPLASTICS MATERIALS)			5955	6		Part 6: Installation of unplasticized PVC pipework for gravity drains and sewers
323	BLUE POLYETHYLENE PIPES UP TO NOMINAL SIZE 63 FOR BELOW GROUND USE FOR POTABLE WATER			6572			
324	BLACK POLYETHLENE PIPES UP TO NOMINAL SIZE 63 FOR ABOVE GROUND USE FOR COLD POTABLE WATER			6730			

3.4 OTHER PIPES AND FITTINGS

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
401	ASBESTOS CEMENT (A/C) PRESSURE PIPES	19800	1-3	486		ISO 160 BS EN 512	BS 486 Withdrawn Replaced by BS EN 512
401	ASBESTOS CEMENT (A/C) PRESSURE PIPES (CONT.)			4624			
402	A/C SEWER PIPES, JOINTS, FITTINGS			3656		ISO 881 BS EN 588-1	BS 3656 Withdrawn Replaced by BS EN 588-1
402	A/C SEWER PIPES, JOINTS, FITTINGS (CONT. 1)						
402	A/C SEWER PIPES, JOINTS, FITTINGS (CONT. 2)	19850	1, 2				
403	A/C PIPES FOR THRUST BORING					ISO 4488	
404	A/C PIPES - GUIDE FOR LAYING			5927		ISO 4482	
405	A/C PIPES - FIELD PRESSURE TESTING	4279	1, 6, 9, 10	5886		ISO 4483	
406	PIPE SUPPORTS	See DVGW		3974	1	DVGW 310 PT. 2	
407	UNREINFORCED CONCRETE PIPES (OGEE)	4032		5911	3		
408	PRESTRESSED CONCRETE PRESSURE PIPES	4035		4625			
409	PRECAST CONCRETE PIPES - DRAINS & SEWERS	4032		5911	1, 3		
409	PRECAST CONCRETE PIPES - DRAINS & SEWERS (CONT.)	4035					
410	CONCRETE POROUS PIPES - UNDER DRAINS			5911	114		
411	NON-PRESSURE DUCTILE IRON PIPES ETC.					ISO 7186	
412	RUBBER AND PLASTIC HOSES AND ASSEMBLIES					ISO 7751	
413	CONCRETE CYLINDRICAL PIPES & FITTINGS METRIC			5911	1-3	AWWA C602-83	BS 5911 Part I: 1981 Withdrawn Replaced by BS 5911 Part 100: 1988 BS 5911 Part 200: 1989 BS 5911 Part 200: 1994
414	CLAY PIPES (SEWERAGE)			65			
415	TESTING OF JOINTED PIPES AND MANHOLES			2005			BS 2005 - Obsolescent
416	CONCRETE PRESSURE PIPES INCLUDING JOINTS AND FITTINGS					BS EN 639	

3.5 VALVES, METERS, HYDRANTS

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
501	DOUBLE FLANGED C.I. GATE VALVES (WATER)			5163		AWWA C203-78	
501	DOUBLE FLANGED C.I. GATE VALVES (WATER) (CONT. 1)	3230	1-3				
501	DOUBLE FLANGED C.I. GATE VALVES (WATER) (CONT. 2)						
501	DOUBLE FLANGED C.I. GATE VALVES (WATER) (CONT. 3)	3352	1, 4				
502	C.I. GATE VALVES - GENERAL			5150			
502	C.I. GATE VALVES - GENERAL (CONT.)	3352	1, 4				
503	C.I. (PARALLEL SLIDE) GATE VALVES - GENERAL			5151			
504	C.I. GLOBE VALVES - GENERAL	3356	1-5	5152			
505	C.I. CHECK VALVES - GENERAL	3202		5153		AWWA C508-82	
505	C.I. CHECK VALVES - GENERAL (CONT.)	See DVGW		6282	1, 4	DVGW-W376	
506	C.I. AND STEEL BUTTERFLY VALVES - GENERAL	3354	1-4	5155		BS EN 593: 1998	BS 5155 Withdrawn Replaced by BS EN 593,: 1998
507	BOURDON TYPE PRESSURE GAUGES			1780		BS EN 837: 1998	BS 1780 Withdrawn Replaced by BS EN 837-1: 1998
508	FLOAT OPERATED VALVES N.D. 500MM			1212	1, 2, 3		
509	FIRE HYDRANTS	3221	1, 2	750			
510	WATER METERS	19648	1-3	5728	1, 2	ISO 4064-1	BS 5728 Part 1 Withdrawn Replaced by BS 5728: Part 7
510	WATER METERS (CONT.)					KS 06-248 1, 2	
511	COPPER ALLOY GATE, CHECK, ETC. VALVES	3352	11				
511	COPPER ALLOY GATE, CHECK, ETC. VALVES (CONT.)			5154			
512	FIRE HOSE COUPLINGS & EQUIPMENT	14244		336			
513	SURFACE BOXES			5834	2, 3		
513	SURFACE BOXES (CONT. 1)						
513	SURFACE BOXES (CONT. 2)						
513	SURFACE BOXES (CONT. 3)						
513	SURFACE BOXES (CONT. 4)						
514	METALLIC BALL VALVES	3357	1-7				DIN 3357 Part 6, 7 Witihdrawn
515	uPVC VALVES	3441	2				
517	FIRE HYDRANT SYSTEMS FOR BUILDINGS			5041	1-5		
518	BUTTERFLY VALVES			5155			
519	DIAPHRAGM VALVES			5156			
520	CAST IRON PLUG VALVES			5158			
521	UNDERGROUND STOPVALVES FOR WATER SERVICES			5433			

3.6 TESTING METHODS AND EQUIPMENT

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
600	NON-DESTRUCTIVE TESTING OF WELDS (TUBES)	8564	1	3889 (6072)	1, 2A	AP15LS	BS 3889 Partially Replaced by 6072
600	NON-DESTRUCTIVE TESTING OF WELDS (TUBES) (CONT.)	50120	1, 2	6072			
601	SOILS FOR CIVIL ENGINEERING PURPOSE - TEST METHODS	18196		1377			
602	TESTING OF PIPELINE FOR WATER (INTERNAL PRESSURE)	4279	1-7, 9, 10				
603	TESTING OF CEMENT	See EDIN		4550	1, 2, 3	BS EN 196-7 EDIN EN75, 112, 114, 15	BS 4550 Part 1 & Part 2 Withdrawn Replaced by BS EN 196-7: 1992
604	MATERIAL TESTING - DOCUMENTATION					ISO 404, EURONORM 21	
605	MEASUREMENT OF WATER FLOW (WATER METERS)					ISO 4064/3	
606	DRINKING WATER QUALITY - TESTING					KS 05-459:5	
607	RECOMMENDATIONS AND CLASSIFICATION FOR TOPSOIL			3882			
608	METHODS OF TESTING MORTARS, SCREEDS AND PLASTERS			4551			
609	STRUCTURAL FIXINGS IN CONCRETE AND MASONRY			5080	1 & 2		Part 1: Method of test for tensile loading Part 2: Method for determination of resistance to loading in shear
610	SIZE OF HARDWOODS AND METHODS OF MEASUREMENT			5450			
611	RECOMMENDATIONS FOR TESTING OF AGGREGATES			5835	1		Part 1: Compactibility test for graded aggregates

3.7 SITE WORK CODES OF PRACTICE

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
650	SITE INVESTIGATIONS	18196		5930			
650	SITE INVESTIGATIONS (CONT.)	18307					
651	WATER SUPPLY	2000	See BS	BS 6007		CP 310	CP 310 Withdrawn Replaced by BS 6007
651	WATER SUPPLY (CONT. 1)	2425	3, 5	BS 8301		CP 301	CP 301 Withdrawn Replaced by BS 8301
651	WATER SUPPLY (CONT. 2)	4046					
651	WATER SUPPLY (CONT. 3)	19630					
652	BUILDING DRAINAGE	1986	2-4	BS 8301		CP 301	CP 301 Withdrawn Replaced by BS 8301
653	WATER PIPELINE CONSTRUCTION	19630					
654	TRENCHING FOR PIPELINES	4124					
655	SEWAGE PIPELINE CONSTRUCTION						
656	WALLING (BRICK & BLOCK MASONRY)	18330	See BS	5390 5628		CP 121	CP 121 Withdrawn Replaced by BS 5390 and BS 5628 Part 3
657	USE OF STRUCTURAL STEEL IN BUILDING	18203	1, 2	449 BS 5950	2	GB 7101-91 SABS 1431	BS 449 Parts 1 and 2 Withdrawn Part 2: Addendum No. 1 (1975) Replaced by BS 5950 Part 5 (1987)
658	SEWERAGE			8005		BS EN 1610	
659	SMALL SEWAGE TREATMENT WORKS AND CESSPOOLS			6297			
660	TEST PUMPING OF WATER WELLS			6316			
661	METHODS OF MEASUREMENT OF LIQUID FLOW IN OPEN CHANNEL			3680	1-10	BS ISO 748 BS ISO 1100-2 ISO TR 8363	BS 3680 Part 3A Withdrawn Replaced by BS ISO 748: 1997 BS 3680 Part 3C Withdrawn Replaced by BS ISO 1100-2 BS 3680 Part 3G Withdrawn Replaced by ISO TR 8363 BS 3680 Parts 3J, 8F, 8G Withdrawn
662	MEASUREMENT OF FLOW IN CLOSED CONDUITS (BY CURRENT METERS OR PITOT STATIC TUBES)					ISO 7194	
663	CONSTRUCTION AND DEMOLITION OF CONCRETE AND MASONRY					ANSI A10, 9-1983	
664	DRAINAGE OF ROOFS AND PAVED AREAS			6367			
665	FOUNDATIONS			8004		CP 2004	CP 2004 Withdrawn Replaced by BS 8004
666	STRUCTURAL USE OF TIMBER			5268		CP 112, 2	CP 112, 2 Withdrawn Replaced by BS 5268 Part 2 BS 5268 Part 3
667	RETAINING WALLS	4085					
668	WATERPROOFING OF BUILDINGS & STRUCTURES	18195	1-4				
669	WATER QUALITY - SAMPLING					ISO 5667/2/3	
670	WELDING PROCEDURES - APPROVAL TESTING			4870	1	BS EN 288-3 BS EN 288-4	BS 4870 Part 1 Withdrawn Replaced by BS EN 288-3 BS 4870 Part 2 Withdrawn Replaced by BS EN 288-4
671	WELDING - APPROVAL TESTING			4871	1	BS EN 287-1 BS EN 287-2	BS 4871 Part 1 Withdrawn Replaced by BS EN 287-1 BS 4871 Part 2 Withdrawn Replaced by BS EN 287-2
672	LOGGING OF ROCK CORES					LOGGING OF ROCK CORES FOR ENGINEERING PURPOSES, GEOL. SOC. OF LONDON	
673	TEST FOR STABILISED SOILS			1924			
674	DRAIN AND SEWER SYSTEMS OUTSIDE BUILDINGS				1, 2 & 3	BS EN 752	Part 1: Generalities and definitions Part 2: Performance requirements Part 3: Planning
675	CONSTRUCTION AND TESTING OF DRAINS AND SEWERS					BS EN 1610	
676	IDENTIFICATION OF PIPELINES AND SERVICES			1710			
677	WELDING OF STEEL PIPELINES ON LAND AND OFFSHORE			4515			
678	PERFORMANCE REQUIREMENTS FOR JOINTS AND COMPRESSION FITTINGS FOR USE WITH POLYETHYLENE PIPES			5114			

679	STRUCTURAL USE OF TIMBER			5268	2, 3 & 5		Part 2: Permissible stress design, materials and workmanship Part 3: Trussed rafter roof Part 5: Preservative treatment of structural timber

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
680	STAIRS, LADDERS AND WALKWAYS			5395	1, 2 & 3		Part 1: Design of straight stairs Part 2: Design of helical and spiral stairs Part 3: Design of industrial type stairs, permanent ladder and walkways
681	INTERNAL PLASTERING			5492			
682	GUIDE TO ACCURACY IN BUILDING			5606			
683	SAFE USE OF EXPLOSIVES IN THE CONSTRUCTION INDUSTRY			5607			
683	USE OF MASONRY			5628	3		Part 3: Materials and components, design and workmanship
684	EARTHWORKS			6031			
685	PAINTING OF BUILDINGS			6150			
686	LOADING FOR BUILDINGS			6399	1		Part 1: Dead and imposed loads
687	GUIDE TO INSTALLATION AND USE OF VALVES			6683			
688	DESIGN, INSTALLATION, TESTING AND MAINTENANCE OF SERVICES SUPPLYING WATER FOR DOMESTIC USE WITHIN BUILDINGS AND THEIR CURTILAGES			6700			
689	GUIDE FOR STRUCTURAL DESIGN OF PAVEMENTS CONSTRUCTED WITH CLAY OR CONCRETE BLOCK PAVER			7533			
690	SEWERAGE			8005	1		Part 1: Guide to new sewerage construction
691	PROTECTION OF STRUCTURES AGAINST WATER FROM THE GROUND			8102			
692	DESIGN AND INSTALLATION OF DAMP-PROOF COURSES IN THE MASONRY CONSTRUCTION			8215			
693	CODE OF PRACTICE FOR BUILT-UP FELT ROOFING			8217			

3.8 DRAWING PRACTICE, STANDARD SYMBOLS ETC.

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
700	IDENTIFICATION OF PIPELINE ACCORDING TO FLUID CONVEYED	2403					
701	GRAPHICAL SYMBOLS FOR GENERAL ENGINEERING - PIPING SYSTEMS	2406		1553	1		
701	GRAPHICAL SYMBOLS FOR GENERAL ENGIINEERING - PIPING SYSTEMS (CONT.)	2429	1				
702	PROJECT NETWORK TECHNIQUES			4335			
703	DRAWING OFFICE PRACTICE - ARCHITECTS AND BUILDERS			1192	1-4		BS 1192 Part 2 Obsolescent
704	CONSTRUCTION DRAWING PRACTICE			1192	1-4		BS 1192 Part 2 Obsolescent
705	ENGINEERING DRAWING PRACTICE			308	1	ISO 128, 2162, 2203	
706	DRAWING PRACTICE FOR ENGINEERING DRAWINGS			5070	1-3	BS EN 61082	BS 5070 Part 1 Partially Replaced by BS EN 61082-1 BS 5070 Part 2 Withdrawn Replaced by BS EN 61082-2
707	BUILDING AND CIVIL ENGINEERING TERMS			6100	1-6		
708	WATER SUPPLY - MAPS AND PLANS	2425	3, 5				
709	CARTOGRAPHIC REPRESENTATION OF CLIMATE	50019	1				
750	CONCRETE (INC. R/F) - GLOSSARY			6100	6.2, 6.3		
751	VALVES - GLOSSARY						
752	IRON AND STEEL - GLOSSARY FOR PIPES			6562	1-2		