WATER SECTION

TENDER INVITATION

SAMPU WATER PIPELINE REHABILITATION AND GABION CONSTRUCTION AT INTAKE DIVERSION WORKS

TCML/WS/RFQ6

August 2016
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To: LICENCED CIVIL/WATER WORKS CONTACTORS (NCA7)

Dear Sirs:

Reference: Sampu water pipeline rehabilitation and gabion construction at the intake diversion works

Interested bidders are invited to tender for the above project. We hereby invite you and other prequalified tenderers to submit a tender for the execution and completion of the above Contract.

A complete set of tender documents may be obtained by you from TATA Chemicals Magadi Ltd

TATA CHEMICALS MAGADI LTD
P O BOX 1 00205, MAGADI
KENYA

All tenders must be accompanied by one (1) number of copies of the same and a 2% bid security in the form and amount specified in the tendering documents, and must be delivered to Procurement Offices, TATA Chemicals Magadi or drop off point at Avon Centre Enterprise Road Nairobi on or before 10th September 2016.

Please confirm receipt of this letter immediately in writing by email, cable/facsimile or telex.

Yours faithfully,

________________________________ Authorised Signature

_____________________________________ Name and Title

1. The request for proposals (RFP) includes the following documents:

Section I - Letter of invitation
Section II - Information to contractors
Section III - Terms of Reference
Section IV - Technical proposals
Section V - Financial proposal
Section VI - Standard Contract Forms
2. SECTION II: - INFORMATION TO CONTRACTORS (ITC)

2.1. INTRODUCTION

1. The Client named the Appendix to “ITC” will select a firm among those invited to submit a proposal, in accordance with the method of selection detailed in the appendix. The method of selection shall be as indicated by the procuring entity in the Appendix.

2. The contractors are invited to submit a Technical Proposal and a Financial Proposal, or a Technical Proposal only, as specified in the Appendix “ITC” for construction services required for the assignment named in the said Appendix. A Technical Proposal only may be submitted in assignments where the Client intends to apply standard conditions of engagement and scales of fees for professional services which are regulated as is the case with Water and Irrigation Construction services. In such a case the highest ranked firm of the technical proposal shall be invited to negotiate a contract on the basis of scale fees quoted. The proposal will be the basis for Contract negotiations and ultimately for a signed Contract with the selected firm.

3. The contractors must familiarize themselves with local conditions and take them into account in preparing their proposals. To obtain firsthand information on the assignment and on the local conditions, contractors are encouraged to liaise with the Client regarding any information that they may require before submitting a proposal and to attend a pre-proposal conference where applicable. Contractors should contact the officials named in the Appendix “ITC” to arrange for any visit or to obtain additional information on the pre-proposal conference. Contractors should ensure that these officials are advised of the visit in adequate time to allow them to make appropriate arrangements.

4. The Procuring entity will provide the inputs specified in the Appendix “ITC”, assist the firm in obtaining licenses and permits needed to carry out the services and make available relevant project data and reports.

5. Please note that (i) the costs of preparing the proposal and of negotiating the Contract, including any visit to the Client are not reimbursable as a direct cost of the assignment; and (ii) the Client is not bound to accept any of the proposals submitted.

6. The procuring entity’s employees, committee members, board members and their relative (spouse and children) are not eligible to participate.

7. The procuring entity shall allow the tenderer to review the tender document free of charge before purchase.
2.2. **Clarification and Amendment of RFP Documents**

1. Contractors may request a clarification of any of the RFP documents only up to seven [7] days before the proposal submission date. Any request for clarification must be sent in writing by paper mail or electronic mail to the Client’s address indicated in the Appendix “ITC” or the official Tata Chemicals Magadi e-tender email address. The Client will respond by electronic mail to such requests and may send written copies of the response (including an explanation of the query but without identifying the source of inquiry) to all invited contractors who intend to submit proposals.

2. At any time before the submission of proposals, the Client may for any reason, whether at his own initiative or in response to a clarification requested by an invited firm, amend the RFP. Any amendment shall be issued in writing through addenda. Addenda shall be sent by mail, to all invited contractors and will be binding on them. The Client may at his discretion extend the deadline for the submission of proposals.

2.3. **Preparation of Technical Proposal**

1. The Contractors proposal shall be written in English language.

2. In preparing the Technical Proposal, contractors are expected to examine the documents constituting this RFP in detail. Material deficiencies in providing the information requested may result in rejection of a proposal.

3. While preparing the Technical Proposal, contractors must give particular attention to the following:

   i. If a firm considers that it does not have all the expertise for the assignment, it may obtain a full range of expertise by associating with individual contractor(s) and/or other firms or entities in a joint venture or sub-construction as appropriate. Contractors shall not associate with the other contractors invited for this assignment. Any firms associating in contravention of this requirement shall automatically be disqualified.

   ii. The proposal shall however be based on the number of professional staff-time estimated by the firm to meet its full obligations to the Client.

   iii. It is desirable that the majority of the key professional staff proposed be permanent employees of the firm or have an extended and stable working relationship with it.

4. The Technical Proposal shall provide the following information using the attached Standard Forms;
i. A brief description of the firm’s organization and an outline of recent experience on assignments of a similar nature.

ii. Any comments or suggestions on the Terms of Reference, a list of services and facilities to be provided by the Client.

iii. A description of the methodology and work plan for performing the assignment including Contractor’s equipment and history of undertaking such Works.

iv. The list of the proposed staff team by specialty, the tasks that would be assigned to each staff team member and their timing.

v. CVs recently signed by the proposed professional staff and the authorized representative submitting the proposal. Key information on the lead Water/Civil engineer should include number of years working for the firm/entity and degree of responsibility held in various assignments during the last ten (10) years.

vi. Estimates of the total staff input (professional and support staff staff-time) needed to carry out the assignment supported by Gantt charts diagrams showing the time proposed for each professional activity.

vii. A detailed description of the proposed methodology, staffing and monitoring of training, if Appendix specifies training as a major component of the assignment.

viii. Contact for references included in Evidence of handling similar works for the last three concurrent years.

ix. Any additional information requested in Appendix and the tender documents.

x. Anyone interested in a site visit will need to organize transportation and armed wardens as the intake is inside an area infested with wild animals. In such cases they will need to place requests for a local guide community guide at their cost.

5. The Technical Proposal shall not include any financial information.

### 2.4. Preparation of Financial Proposal

1. In preparing the Financial Proposal, contractors are expected to take into account the requirements and conditions outlined in the RFP documents. The Financial Proposal should follow Standard Forms. It lists all costs associated with the assignment including: (a) remuneration for staff (in the field and at headquarters), and, transportation (international and local, for mobilization and demobilization), services and equipment.
vehicles, office equipment, furniture, and supplies), office rent, insurance, printing of documents, surveys, and training, if it is a major component of the assignment. If appropriate these costs should be broken down by activity and shall be assumed to be covered by the Contractor and fully captured by the total contract sum quoted.

2. The Financial Proposal should clearly identify as a separate amount, the local taxes, duties, fees, levies and other charges imposed under the law on the contractors, the subcontractors and their personnel.

3. Contractors shall express the price of their services in Kenya Shillings.

4. Commissions and gratuities, if any, paid or to be paid by contractors and related to the assignment will be listed in the Financial Proposal submission Form (Not Applicable).

5. The Proposal must remain valid for 90 working days after the submission date. During this period, the contractor is expected to keep available, at his own cost, the professional staff proposed for the assignment. The Client will make his best effort to complete negotiations within this period. If the Client wishes to extend the validity period of the proposals, the contractors shall agree to the extension.

6. Audited Financial statements for the last three concurrent years
2.5. Submission, Receipt, and Opening of Proposals

The original proposal (Technical Proposal and, if required, Financial Proposal) shall be prepared in indelible ink. It shall contain no interlineation or overwriting, except as necessary to correct errors made by the firm itself. Any such corrections must be initialed by the persons or person authorized to sign the proposals.

The completed Technical and Financial Proposals must be delivered at the submission address on or before the time and date stated in the Appendix “ITC”. Any proposal received after the closing time for submission of proposals shall be returned to the respective contractor unopened.

After the deadline for submission of proposals, the Technical Proposal shall be opened immediately by the opening committee. The Financial Proposal shall remain sealed and deposited with a responsible officer of the client department up to the time for public opening of financial proposals.

The bidders must supply all necessary documents for such work as required by laws of Kenya, this includes but not limited to:

1. Recent Tax Compliant Certificate
2. Business Registration Certificate
3. Income Tax Certificate
4. Latest Proof of Compliance with National Construction Authority Act 2011 and National Construction Authority 2014. Certified copies of Certificates of Registration with the said NCA category (7) and any other Relevant Authorities
5. Company Profile and audited financial statements for the last three concurrent years.
6. Total monetary value of Contract Works performed for the last three years;
7. Names and contact details of clients for whom works were undertaken; including completion certificates.
8. Major Equipment owned.
9. Qualification and experience of Key Personnel
10. Authority to seek references from Bankers and Clients
11. Copies of PIN and VAT Registration Certificates
12. An indication of the principal place of business

2.6. Proposal Evaluation General

From the time the bids are opened to the time the Contract is awarded, if any contractor wishes to contact the Client on any matter related to his proposal, he should do so in writing at the address indicated in the Appendix “ITC”. Any effort by the firm to influence the Client in the proposal evaluation, proposal comparison or Contract award decisions may result in the rejection of the contractor’s proposal.

Evaluators of Technical Proposals shall have no access to the Financial Proposals until the technical evaluation is concluded.

2.6.1. Evaluation of Technical Proposal

The evaluation committee appointed by the Client shall evaluate the proposals on the basis of their responsiveness to the Terms of Reference, applying the evaluation criteria as follows

<table>
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<tr>
<th>Points</th>
<th>Criteria</th>
</tr>
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<tbody>
<tr>
<td>(5-10)</td>
<td>Specific experience of the contractor related to the assignment</td>
</tr>
<tr>
<td></td>
<td>Adequacy of the proposed work plan and</td>
</tr>
</tbody>
</table>
methodology in responding to the terms of reference (20-40)

(iii) Contractor equipment (30-40)

(iv) Qualifications and competence of the key staff for the

...........

Total Points 100
Each responsive proposal will be given a technical score ($St$). A proposal shall be rejected at this stage if it does not respond to important aspects of the Terms of Reference or if it fails to achieve the minimum technical score indicated in the Appendix “ITC”.

### 2.6.2. OPENING AND EVALUATION OF FINANCIAL PROPOSAL

1. After Technical Proposal evaluation, at his convenience and prerogative the Client shall notify those contractors whose proposals did not meet the minimum qualifying mark or were considered non-responsive to the RFP and Terms of Reference, indicating that their Financial Proposals will be returned after completing the selection process. The Client shall simultaneously notify the contractors who have secured the minimum qualifying mark, indicating the date and time set for opening the Financial Proposals and stating that the opening ceremony is open to those contractors who choose to attend. The opening date shall not be sooner than seven (7) days after the notification date. The notification may be sent by registered letter, cable, telex, facsimile or electronic mail.

2. The Financial Proposals shall be opened at TCML, the name of the contractor, the technical. Scores and the proposed prices shall be read aloud and recorded when the Financial Proposals are opened. The Client shall prepare minutes of the tender opening.

3. The evaluation committee will determine whether the financial proposals are complete (i.e. whether the contractor has costed all the items of the corresponding Technical Proposal and correct any computational errors. The cost of any unpriced items shall be assumed to be included in other costs in the proposal. In all cases, the total price of the Financial Proposal as submitted shall prevail.

4. The formulae for determining the Financial Score ($Sf$) shall, unless an alternative formulae is indicated in the Appendix “ITC”, be as follows

\[ Sf = 100 \times \frac{FM}{F} \]

where $Sf$ is the financial score; $Fm$ is the lowest priced financial proposal and $F$ is the price of the proposal under consideration. Proposals will be ranked according to their combined technical ($St$) and financial ($Sf$) scores using the weights ($T$=the weight given to the Technical Proposal; $P$=the weight given to the Financial Proposal; $T + P = 1$) indicated in the Appendix. The combined technical and financial score, $S$, is calculated as follows:-

\[ S = St \times T \% + Sf \times P \% \]

The firm achieving the highest combined technical and financial score will be invited for negotiations.

5. The tender evaluation committee shall evaluate the tender within 15 days of from the date of opening the tender.

6. Contract price variations shall not be allowed for contracts not exceeding one year (12 months). They shall be limited to agreements and approval by Engineer as described in the technical specifications.
2.6.3. **NEGOTIATIONS**

1. Negotiations will be held at the same address as “address to send information to the Client” indicated in the Appendix “ITC”. The aim is to reach agreement on all points and sign a contract.

2. Negotiations will include a discussion of the Technical Proposal, the proposed methodology (work plan), staffing and any suggestions made by the firm to improve the Terms of Reference. The Client and firm will then work out final Terms of Reference, staffing and bar charts indicating activities, staff periods in the field and in the head office, staff-months, logistics and reporting. The agreed work plan and final Terms of Reference will then be incorporated in the “Description of Services” and form part of the Contract. Special attention will be paid to getting the most the firm can offer within the available budget and to clearly defining the inputs required from the Client to ensure satisfactory implementation of the assignment.

3. Unless there are exceptional reasons, the financial negotiations will not involve the remuneration rates for staff (no breakdown of fees).

4. Having selected the firm on the basis of, among other things, an evaluation of proposed key professional staff, the Client expects to negotiate a contract on the basis of the expertise named in the proposal. Before contract negotiations, the Client will require assurances that the experts will be actually available. The Client will not consider substitutions during contract negotiations unless both parties agree that undue delay in the selection process makes such substitution unavoidable or that such changes are critical to meet the objectives of the assignment. If this is not the case and if it is established that key staff were offered in the proposal without confirming their availability, the firm may be disqualified.

5. The negotiations will conclude with a review of the draft form of the Contract. To complete negotiations the Client and the selected firm will initial the agreed Contract. If negotiations fail, the Client will invite the firm whose proposal received the second highest score to negotiate a contract.

6. The procuring entity shall appoint a team for the purpose of the negotiations.

**2.6.4. AWARD OF CONTRACT**

The Contract will be awarded following negotiations. After negotiations are completed, the Client will promptly notify other contractors on the shortlist that they were unsuccessful and return the Financial Proposals of those contractors who did not pass the technical evaluation.
The selected firm is expected to commence the assignment on the date and at the location specified in Appendix.

The parties to the contract shall have it signed within 10 days from the date of notification of contract award unless there is an administrative review request.

The procuring entity may at any time terminate procurement proceedings before contract award and shall not be liable to any person for the termination.

The procuring entity shall give prompt notice of the termination to the tenderers and on request give its reasons for termination within 7 days of receiving the request from any tenderer.

To qualify for contract awards, the tenderer shall have the following:

- Necessary qualifications, capability experience, services, equipment and facilities to provide what is being procured.
- Legal capacity to enter into a contract for procurement
- Shall not be insolvent, in receivership, bankrupt or in the process of being wound up and is not the subject of legal proceedings relating to the foregoing.
- Shall not be debarred from participating in public procurement.
2.6.5. CONFIDENTIALITY

Information relating to evaluation of proposals and recommendations concerning awards shall not be disclosed to the contractors who submitted the proposals or to other persons not officially concerned with the process, until the winning firm has been notified that it has been awarded the Contract.

2.6.6. CORRUPT OR FRAUDULENT PRACTICES

The procuring entity requires that the contractors observe the highest standards of ethics during the selection and award of the construction contract and also during the performance of the assignment. The tenderer shall sign a declaration that he has not and will not be involved in corrupt or fraudulent practices.

The procuring entity will reject a proposal for award if it determines that the contractor recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question.
The following information for procurement of construction services and selection of contractors shall complement or amend the provisions of the information to contractors, wherever there is a conflict between the provisions of the information and to contractors and the provisions of the appendix, the provisions of the appendix herein shall prevail over those of the information to contractors.

The name of the Client is; TATA CHEMICALS MAGADI LIMITED

The main contact person is; Procurement Manager, Water Engineer (Technical Clarifications)

The method of selection is: Competitive bidding

Technical and Financial Proposals are requested: Yes

The name, objectives, and description of the assignment are Sampu water pipeline rehabilitation and gabion construction at the intake diversion works. There is an existing intake which is functional. The project only seeks to stabilize flows into the diversion channel due to increased demand. The materials needed are as per Bills of Quantities and the works will be supervised by the TCML Water Engineer or his officially appointed representative.

A pre-proposal conference will be held: No

The name(s), address(es) and telephone numbers of the Client’s official(s) are;

The Client will provide the following inputs: Information regarding the scope of works and any other clarifications regarding the work. In case Contractors need a site visit they will need to give a 7 days’ notice and also plan to hire two armed wardens to access the intake site. The cost for Construction shall be assumed to cover all costs expected by the Contractor in discharging his work and delivering the expectations as per this RFP.

The estimated number of professional staff months required for the assignment is; 2 Calendar Months

The minimum required experience of proposed firm is: At least 10 years’ experience of pipeline and intake works construction experience.

Contractor Equipment; The Contractor MUST have all equipment for completion of the assignment including material and personnel transport and as required in the technical specification for all Works in this tender document.

Materials and storage; this shall be as per the technical specifications and tender documents

Additional information in the Technical Proposal includes:

Taxes: All tax obligations of the Contractor are assumed to be captured in the financial offer and any other accruing charges regarding the discharging of the Contractor’s duties are his/her obligations.

Contractors must submit an original a copy of each proposal.

The proposal submission address is:

TATA Chemicals Magadi Ltd

Procurement and Supplies Section

ATTENTIONED TO; Procurement Manager

P O BOX 1 Magadi
Proposals must be submitted no later than the following date and time: 10\textsuperscript{th} September 2016

The address to send information to the Client is:
The proposal submission address is:
TATA Chemicals Magadi Ltd
Procurement and Supplies Section
ATTENTIONED TO; Procurement Manager
P O BOX 1 Magadi
CODE 00205
Email:

The minimum technical score required to pass is 65%
There is no alternative formulae for awarding the financial score
The Total score is the sum of the Technical Proposal and Financial Proposal
The weights given to the Technical and Financial Proposals are:
T=___________ (0.80)
P=___________ (0.10)
The assignment is expected to commence on 14\textsuperscript{th} day after Contract signing
3.1. SECTION III: - TECHNICAL PROPOSAL

3.1.1. NOTES ON THE PREPARATION OF THE TECHNICAL PROPOSALS

1. In preparing the technical proposals the contractor is expected to examine all terms and information included in the RFP. Failure to provide all requested information shall be at the contractor’s own risk and may result in rejection of the contractor’s proposal.

2. The technical proposal shall provide all required information and any necessary additional information and shall be prepared using the standard forms provided in this Section.

3. The Technical proposal shall not include any financial information unless it is allowed in the Appendix to information to the contractors or the Special Conditions of contract.
1. TECHNICAL PROPOSAL SUBMISSION FORM

[_______________ Date]

To:______________________ [Name and address of Client)

Ladies/Gentlemen:

We, the undersigned, offer to provide the construction services for Sampu water pipeline rehabilitation and gabion placing at the intake diversion works in accordance with your Request for Proposal dated ______________________ [Date] and our Proposal. We are hereby submitting our Proposal, which includes this Technical Proposal, [and a Financial Proposal sealed under a separate envelope—where applicable].

We understand you are not bound to accept any Proposal that you receive.

We remain,

Yours sincerely,

______________________________ [Authorized Signature]:

________________________________ [Name and Title of Signatory]

________________________________ [Name of Firm]

________________________________ [Address:]
### 2. Firm's References

**Relevant Services Carried Out in the Last Five Years**

**That Best Illustrate Qualifications**

Using the format below, provide information on each assignment for which your firm either individually, as a corporate entity or in association, was legally contracted.

<table>
<thead>
<tr>
<th>Assignment Name:</th>
<th>Country</th>
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<tr>
<th>Location within Country:</th>
<th>Professional Staff provided by Your Firm/Entity(profiles):</th>
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<tr>
<th>Name of Client:</th>
<th>Clients contact person for the assignment.</th>
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<table>
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<tr>
<th>Address:</th>
<th>No of Staff-Months; Duration of Assignment:</th>
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<tr>
<th>Start Date (Month/Year): Completion Date</th>
<th>Approx. Value of Services (Kshs)</th>
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<tr>
<th>Name of Associated Contractors. If any:</th>
<th>No of Months of Professional Staff provided by Associated Contractors:</th>
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</table>

**Name of Senior Staff (Project Director/Coordinator, Team Leader) Involved and Functions Performed:**

**Narrative Description of project:**

**Description of Actual Services Provided by Your Staff:**

---

**Firm’s Name:** ________________________________

**Name and title of signatory:** __________________________

*(May be amended as necessary)*
3. **COMMENTS AND SUGGESTIONS OF CONTRACTORS ON THE TERMS OF REFERENCE AND ON DATA, SERVICES AND FACILITIES TO BE PROVIDED BY THE CLIENT.**

---

**On the Terms of Reference:**

1.

2.

3.

4.

5.

---

**On the data, services and facilities to be provided by the Client:**

1.

2.

3.

4.

5.
14. DESCRIPTION OF THE METHODOLOGY AND WORK PLAN FOR PERFORMING THE ASSIGNMENT
5. **TEAM COMPOSITION AND TASK ASSIGNMENTS**

1. **Technical/Managerial Staff**

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<th>Name</th>
<th>Position</th>
<th>Task</th>
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2. **Support Staff**

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<th>Position</th>
<th>Task</th>
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</table>
6. FORMAT OF CURRICULUM VITAE (CV) FOR Team Leader

Proposed Position: ________________________________

Name of Firm: ____________________________________

Name of Staff: ______________________________________

Profession: ________________________________________

Date of Birth: ______________________________________

Years with Firm: ___________________________ Nationality: ______________________

Membership in Professional Societies: ________________________________

Detailed Tasks Assigned: ______________________________________

Key Qualifications:

[Give an outline of staff member’s experience and training most pertinent to tasks on assignment. Describe degree of responsibility held by staff member on relevant previous assignments and give dates and locations].

Education:

[Summarize college/university and other specialized education of staff member, giving names of schools, dates attended and degree[s] obtained.]

Employment Record:

[Starting with present position, list in reverse order every employment held. List all positions held by staff member since graduation, giving dates, names of employing organizations, titles of positions held, and locations of assignments.]

Certification:
I, the undersigned, certify that these data correctly describe me, my qualifications, and my experience.

_________________________________________________________ Date:

[Signature of staff member]

_________________________________________________________ Date;

[Signature of authorised representative of the firm]

Full name of staff member:

_________________________________________________________

Full name of authorized representative: ________________________________
# 7. Time Schedule for Professional Personnel

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Reports Due/Activities</th>
<th>1</th>
<th>2</th>
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Reports Due: __________

Activities Duration: __________

Signature: ________________________

(Authorized representative)

Full Name: ________________________

Title: ____________________________

Address: __________________________
8. **ACTIVITY (WORK) SCHEDULE**

(a). Field Investigation and Study Items and construction, testing and commissioning


dates are months from the start of assignment

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3.2. SECTION IV: - FINANCIAL PROPOSAL

3.2.1. NOTES ON PREPARATION OF FINANCIAL PROPOSAL

1. The Financial proposal prepared by the contractor should list the costs associated with the assignment. These costs normally cover remuneration for staff, subsistence, transportation, services and equipment, printing of documents, surveys etc as may be applicable. The costs should be broken down to be clearly understood by the procuring entity.

2. The financial proposal shall be in Kenya Shillings or any other currency allowed in the request for proposal and shall take into account the tax liability and cost of insurances specified in the request for proposal.
4. SECTION V; TERMS OF REFERENCE FOR CONTRACTOR

4.1. APPENDIX A: TERMS OF REFERENCE AND SCOPE OF SERVICES

The contractor is expected to supply the requirements of this Request for Quotation and include in his submissions the following:

4.1.1. BACKGROUND INFORMATION

TATA Chemicals Magadi Limited is an organization located within Magadi area of Kajiado County. The company wishes to begin the rehabilitation of Sampu Water Supply system. The system was built in 1979 and supplies (4) four group ranches. The demand for water over the years has increased and the natural river flows subsided especially during the dry season. For this reason coupled with dilapidated pipeline infrastructure, non-metering of distribution and leakages in the pipeline and reservoirs, TCML wishes to rehabilitate the system and ensure that all group ranches get water and the pipeline is well metered with minimal water losses including spillages at the community water tanks along its length.

4.1.2. OBJECTIVES AND SCOPE OF THE ASSIGNMENT

The objective of the assignment is for the Contractor to;

- Build Gabions and gunny bags at intake to increase diverted water for community
- Replace sections of the pipeline that are badly leaking
- Install water meters in on selected branches along the main pipeline
- Install taps, ball valves and other fittings as described in the Bills of Quantities
- Build lockable chambers along the pipeline where meters are installed

- The materials standards and works Standards to be applied are as the Design Manual for Water Supply in Kenya 2005
- Test and commission the replaced pipeline system to TCML’s Water Engineer’s approval

4.2. APPENDIX B; REPORTING SYSTEMS AND TIME SCHEDULES

There shall be weekly meetings between the contractor and the client as requested by either side with one (1-3) calendar days’ notice by email and follow up by phone call. Delays in work due to such a meeting shall be remedied if they exceed the 3 mentioned days. The meeting shall have its minutes recorded and a copy sent to the Contractor with the original minutes to be deposited at the Water Engineer’s office.

The Contractor is expected to produce the following reports to the Water Engineer;

- Weekly progress reports detailing works carried out, any amendments, measured completed works etc.
- Monthly payment certificates
- Final Project Completion report
4.3. TERMS OF PAYMENT

After completion of the assignment the Contractor shall be expected to submit a Draft Copy soft and hard copy of the pipeline system. Where need be payment shall be through approved interim payment certificate approved by the Water Engineer. Any down payment shall be as agreed with TCML Procurement department. The interim payments certificate shall be as per measured works, goods delivered and certified as completed successfully by the appointed Water Engineer. In case any advance payment is agreed, it shall not be more than 30% the cost of measured works for the period to be covered by a particular payment certificate as per works implementation program forwarded by Contractor. The final completion certificate shall be mandatory for final payments to be done. This shall be issued after successful testing and commissioning of the project and submission of the below requirements.

The Final submission shall comprise off;

i. General Technical ‘As Built Drawings’ and detailed drawings for all components of the expected works.

ii. A project completion report
The contractor shall be expected to supply the following standard forms in his bid.

i. Form of Tender
ii. Letter of Acceptance
iii. Form of Agreement
iv. Form of Tender Security (2%) and Powers of Attorney
v. Performance Bank Guarantee (10%)
vi. Bank Guarantee for Advance Payment (Not Applicable incase there is no advance payment, in case of advance payment agreed between Parties to the Contract this shall be as per negotiated and agreed terms)
vii. Qualification Information
viii. Details of Sub-Contractors

The format for the above shall be as per the below standard formats;
5.1. FORM OF TENDER

TO: __________________________ [Name of Employer] ____________ [Date]

__________________________ [Name of Contract]

Dear Sir,

1. In accordance with the Conditions of Contract, Specifications, Drawings and Bills of Quantities for the execution of the above named Works, we, the undersigned offer to construct, install and complete such Works and remedy any defects therein for the sum of Kshs. __________________________ [Amount in figures] Kenya Shillings

__________________________ [Amount in words]

2. We undertake, if our tender is accepted, to commence the Works as soon as is reasonably possible after the receipt of the Project Manager’s notice to commence, and to complete the whole of the Works comprised in the Contract within the time stated in the Appendix to Conditions of Contract.

3. We agree to abide by this tender until _________________ [Insert date], and it shall remain binding upon us and may be accepted at any time before that date.

4. Unless and until a formal Agreement is prepared and executed this tender together with your written acceptance thereof, shall constitute a binding Contract between us.

5. We understand that you are not bound to accept the lowest or any tender you may receive.

Dated this _________________ day of ___________ 20________

Signature __________________ in the capacity of __________________________

duly authorized to sign tenders for and on behalf of __________________________ [Name of Employer]
of ________________ [Address of Employer]

Witness; Name__________________________

Address_____________________________________

Signature_____________________________________

Date_________________________________________
5.2. LETTER OF ACCEPTANCE

[date]

To: _______________________

[name of the Contractor]

_____________________

[address of the Contractor]

Dear Sir,

This is to notify you that your Tender dated ___________________________

for the execution of  ________________________________________________

[name of the Contract and identification number, as given in the Tender documents] for the Contract

Price of Kshs. __________________________ [amount in figures][Kenya Shillings________________________(amount in words) ] in accordance with the

Instructions to Tenderers is hereby accepted.

You are hereby instructed to proceed with the execution of the said Works in accordance with the

Contract documents.

Authorized Signature  ……………………………………………………………

Name and Title of Signatory  ……………………………………………………

Attachment : Agreement
**5.3. FORM OF AGREEMENT**

THIS AGREEMENT, made the _________________ day of ________ 20 ______ between________________________________________________of[or whose registered office is situated at]__________________________________________

(hereinafter called “the Employer”) of the one part AND

________________________________________________________of[or whose registered office is situated at]___________________________

(hereinafter called “the Contractor”) of the other part.

WHEREAS THE Employer is desirous that the Contractor executes

________________________________________________________

(name and identification number of Contract ) (hereinafter called “the Works”) located at______________________________[Place/location of the Works] and the Employer has accepted the tender submitted by the Contractor for the execution and completion of such Works and the remediing of any defects therein for the Contract Price of Kshs___________________________[Amount in figures],Kenya Shillings_____________________________________________[Amount in words].

NOW THIS AGREEMENT WITNESSETH as follows:

1. In this Agreement, words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.

2. The following documents shall be deemed to form and shall be read and construed as part of this Agreement i.e.

   i. Letter of Acceptance
   ii. Form of Tender
   iii. All Conditions of Contract
   iv. All Technical and Financial Specifications
   v. Drawings (Where available)
   vi. Priced Bills of Quantities

3. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy any defects therein in conformity in all respects with the provisions of the Contract.

4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remediing of defects therein, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.
IN WITNESS whereof the parties thereto have caused this Agreement to be executed the day and year first before written.

The common Seal of _________________________________________________

Was hereunto affixed in the presence of ________________________________

Signed Sealed, and Delivered by the said ________________________________

Binding Signature of Employer _________________________________________

Binding Signature of Contractor _________________________________________

In the presence of (i) Name___________________________________________

Address___________________________________________________________

Signature__________________________________________________________

[ii] Name__________________________________________________________

Address___________________________________________________________

Signature__________________________________________________________
5.4. FORM OF TENDER SECURITY

WHEREAS ...........................................................................................................................................................................
(hereinafter called “the Tenderer”) has submitted his tender dated ........................................................................................................
for the construction of ........................................................................................................................................................................
........................................................................................................
(name of Contract)

KNOW ALL PEOPLE by these presents that WE ........................................................................................................
having our registered office at ........................................................................................................
hereinafter called “the Bank”), are bound unto ........................................................................................................
hereinafter called “the Employer” in the sum of Kshs........................................................................................................
for which payment well and truly to be made to the said Employer, the Bank binds itself, its successors and assigns by these presents sealed
with the Common Seal of the said Bank this ................. Day of ..........20..........

THE CONDITIONS of this obligation are:

1. If after tender opening the tenderer withdraws his tender during the period of tender validity specified in the instructions to tenderers

Or

2. If the tenderer, having been notified of the acceptance of his tender by the Employer during the period of tender validity:

   (a) fails or refuses to execute the form of Agreement in accordance with the Instructions to Tenderers, if required; or
   (b) fails or refuses to furnish the Performance Security, in accordance with the Instructions to Tenderers;

We undertake to pay to the Employer up to the above amount upon receipt of his first written demand, without the Employer having to substantiate his demand, provided that in his demand the Employer will note that the amount claimed by him is due to him, owing to the occurrence of one or both of the two conditions, specifying the occurred condition or conditions.

This guarantee will remain in force up to and including thirty (30) days after the period of tender validity, and any demand in respect thereof should reach the Bank not later than the said date.

_________________________________________  ______________________________________
[date]  [signature of the Bank]

_________________________________________
[witness]  [seal]

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5.5. PERFORMANCE BANK GUARANTEE

To: _________________________(Name of Employer)   _________(Date)
    ____________________________(Address of Employer)

Dear Sir,

WHEREAS ______________________(hereinafter called “the Contractor”) has undertaken, in pursuance of Contract No. _________ dated _________ to execute _______________ (hereinafter called “the Works”);

AND WHEREAS it has been stipulated by you in the said Contract that the Contractor shall furnish you with a Bank Guarantee by a recognised bank for the sum specified therein as security for compliance with his obligations in accordance with the Contract;

AND WHEREAS we have agreed to give the Contractor such a Bank Guarantee:

NOW THEREFORE we hereby affirm that we are the Guarantor and responsible to you, on behalf of the Contractor, up to a total of Kshs. ________________ (amount of Guarantee in figures) Kenya Shillings__________________________________________ (amount of Guarantee in words), and we undertake to pay you, upon your first written demand and without cavil or argument, any sum or sums within the limits of Kenya Shillings _________________________ (amount of Guarantee in words) as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified therein.

We hereby waive the necessity of your demanding the said debt from the Contractor before presenting us with the demand.

We further agree that no change, addition or other modification of the terms of the Contract or of the Works to be performed thereunder or of any of the Contract documents which may be made between you and the Contractor shall in any way release us from any liability under this Guarantee, and we hereby waive notice of any change, addition, or modification.

This guarantee shall be valid until the date of issue of the Certificate of Completion.

SIGNATURE AND SEAL OF THE GUARANTOR  ___________________

Name of Bank  ____________________________________________

Address  ________________________________________________

Date  ____________________________________

(a)
5.6. BANK GUARANTEE FOR ADVANCE PAYMENT

To: ___________________________ [name of Employer] __________(Date)
__________________________ [address of Employer]

Gentlemen,

Ref: ____________________________________________ [name of Contract]

In accordance with the provisions of the Conditions of Contract of the above-mentioned Contract,
We, _______________________________________[name and Address of Contractor] (hereinafter
called “the Contractor”) shall deposit with ____________________________ [name of
Employer] a bank guarantee to guarantee his proper and faithful performance under the said
Contract in an amount of Kshs.________________________ [amount of Guarantee in figures] Kenya
Shillings ____________________________ [amount of Guarantee in words].

We, ___________________ [bank or financial institution], as instructed by the Contractor, agree
unconditionally and irrevocably to guarantee as primary obligor and not as Surety merely, the
payment to ____________________________ [name of Employer] on his first demand without
whatsoever right of objection on our part and without his first claim to the Contractor, in the
amount not exceeding Kshs________________________ [amount of Guarantee in figures] Kenya
Shillings ____________________________ [amount of Guarantee in words], such amount to be reduced periodically by the amounts recovered by you
from the proceeds of the Contract.

We further agree that no change or addition to or other modification of the terms of the Contract
or of the Works to be performed thereunder or of any of the Contract documents which may be
made between ________________________ [name of Employer] and the Contractor, shall in any
way release us from any liability under this guarantee, and we hereby waive notice of any such
change, addition or modification.

No drawing may be made by you under this guarantee until we have received notice in writing
from you that an advance payment of the amount listed above has been paid to the Contractor
pursuant to the Contract.

This guarantee shall remain valid and in full effect from the date of the
advance payment under the Contract until
______________________________________________ (name of Employer) receives full payment
of the same amount from the Contract.

Yours faithfully,

Signature and Seal ____________________________________________

Name of the Bank or financial institution ____________________________

Address _______________________________________________________

Date __________________________________________________________

Witness: Name: ____________________________________________
6. TECHNICAL SPECIFICATION FOR CONSTRUCTION WORKS

6.1. GENERAL TECHNICAL SPECIFICATIONS

6.1.1. GENERAL DESCRIPTION OF THE WORKS

The main works to be undertaken under this contract comprise the following subject to any variations by the Employer:

i. Build Gabions and gunny bags at intake to increase diverted water for community
ii. Replace sections of the pipeline that are badly leaking
iii. Install water meters in on selected branches along the main pipeline
iv. Install taps, ball valves and other fittings as described in the Bills of Quantities
v. Build lockable chambers along the pipeline where meters are installed

The above shall be as specified in these tender document technical specification read jointly with the Bills of Quantities.

6.1.2. STANDARD SPECIFICATIONS

For convenience and in order to establish the necessary standards of quality, reference has been made to specifications issued by national or other widely recognised bodies. Such specifications shall be referred to as ‘Standard Specifications’ and shall be the latest editions of such Standard Specifications issued prior to the issue of these Tender documents together with such additions or amendments as may have been issued prior to the same date.

Subject to the written approval of the Engineer, any other internationally accepted Standard Specification which requires an equal quality of work may be used.

If the Contractor proposes to use a Standard Specification other than that specified, three copies of the proposed Standard Specification in English, shall be submitted to the Employer’s Representative not less than 28 days before approval of Standard Specification is required.

In referring to Standard Specifications, the following abbreviations are used:

BS         British Standard
ISO        International Organisation for Standardisation
ASTM       American Society for Testing and Materials
ASA        American Standards Association
KBS        Kenya Bureau of Standards
KS         Kenya standard
6.1.3. WORKS DESIGNED BY THE CONTRACTOR

All drawings, calculations, plans, reports, instruction manuals, pamphlets, data and all other documents required to be submitted by the Contractor under the Contract shall be clear and readable. The Contractor shall submit these drawings and documents in a logical order to the Engineer for review or approve at least six (6) calendar days prior to execution of the Works unless agreed otherwise in writing by the Engineer.

All shop drawings, including field erection, layout and construction details shall be furnished by the Contractor for the approval of the Employer’s Representative.

All the drawings and calculation to substantiate the design shall be checked, signed and approved by the Contractor prior to submission. The drawings shall also be signed by a qualified Engineer responsible for the design.

Approval of the drawings by the Engineer shall not be construed as a complete check but will indicate only that the general method and detailing is satisfactory. The approval by the Engineer shall not relieve the Contractor of the requirement of the Contract or responsibility for correct installation and assembly of parts in final position or responsibility for the adequacy of method of construction.

All the cost thereof will be deemed to be included in the Contractor’s unit rates and Contract sum.

6.1.4. AS BUILT DRAWINGS

Within four (4) days after the receipt of the Completion Certificate, the Contractor shall submit to the Engineer all the approved drawings and documents (including operation and maintenance manuals), clearly revised and brought up to date by the Contractor to show the permanent construction actually made. The submission shall be made in the following manner and quantity:

- One (1) set of the digital version (ArcGIS shape files and AutoCAD files of all assets under this contract) reproducible drawings of high quality.
- One (1) set of the A1 size blue print.
- The submission shall contain the drawing index.
- No separate payments will be made for the provision of the drawings as the cost thereof shall be deemed to be included in the unit rates and the Contract Sum.
Site Meetings

The Contractor shall be obliged to attend all meetings at the appointed time. The discussions of such meetings shall include but not be limited to the progress of work and problems having direct bearing on the immediate and long term activities (construction, procurement, transport, labour etc).

The Engineer shall represent the Employer in such meetings.

Level Datum

The survey control points and benchmarks if shown on the drawings shall be handed over to the Contractor as basis for surveying and setting out of Works. The Contractor shall be responsible for carrying out the field surveys for the performance of the Works.

Before using the control points and bench marks for setting out of the Works, the Contractor shall carry out a check survey thereon and satisfy himself as to their accuracy. The Employer shall bear no responsibility for the accuracy of any control point or benchmark.

The Contractor may establish additional temporary bench marks for his own convenience but each temporary bench mark shall be of a design and in a location approved by the Engineer and shall be accurate in relation to the bench marks established by the Engineer. The Contractor shall before commencing execution of any given section of the Works submit to the Engineer complete setting out details with supporting calculations and drawings (including drawings showing the locations and co-ordinates of the reference points used) in duplicate for approval.

The Contractor shall identify setting out dimensions for all structures by relating them to existing Works and by interpretation of the Drawings. The gradients of pipelines and the other hydraulic structures shall be as shown on the drawings by TCML unless otherwise required or approved by the Engineer.

The locations of structures to be constructed as part of the Works shall be identified by reference to steel pins set in concrete or other approved markers set up by the Contractor, who shall also determine the co-ordinates of the markers and their distances from adjacent existing structures.

The Contractor shall establish reference co-ordinate points at intervals of not more than 500 m along all major pipelines above 160 mm and these points shall be located and clearly marked at approved locations either on existing buildings or by means of steel pins fixed in concrete.

The Contractor shall set out sections of the Works at such times as may be directed by the Engineer to enable Service Authorities to carry out temporary or permanent alterations to their equipment or buried services.

The Contractor shall protect the reference points and level bench marks and in the event of any damage he shall re-survey and re-establish the points and bench marks.

Any design survey errors shall be brought to the attention of the Engineer immediately before the contractor proceeds with work for further direction. This direction shall be communicated to the contractor by the Engineer within 5 working days.

Setting Out

The Contractor shall appoint and employ the necessary qualified and experienced staff to set out the Works accurately. The Contractor shall establish and locate all lines and levels and be responsible for the correct location of all Works.
The survey instruments to be used by the Contractor shall be of the modern type and make, and suitable for the work to be executed and shall be maintained in a first class condition. The instruments and/or equipment shall be subject to the approval of the Engineer, for all survey, instruments used in the Works the Contractor shall submit recent calibration certificates issued by competent authorities. Further calibration of the instruments shall be carried out every six months.

All field-books, calculations, maps, etc. of the survey activities mentioned above shall be handed over to the Engineer immediately after the completion of the survey work. The Contractor shall provide the necessary skilled and unskilled labour and materials to the Engineer to enable him to check and approve the levels and

Where directed by the Engineer, the Contractor shall take such levels and dimensions as may be required for the purposes of measurements prior to disturbance of the ground. These shall be agreed between the Contractor and the Engineer in writing before any of the surface is disturbed or covered up.

**Construction and Checking of Work**

The Contractor shall be solely responsible for and shall provide all labour, tools, lifting tackle and other equipment required for the construction and checking of the Works.

No operatives shall be allowed to execute any type of work, which is normally carried out by a skilled tradesman, unless the operative is thoroughly experienced and proficient in the trade concerned. Supervisors and operatives may be required to demonstrate their proficiency or produce certificate of competence to the satisfaction of the Engineer.

As each part of the work is carried out it shall be subject to the approval by the Engineer.

**Supervision and Labour**

The Contractor will be required to maintain a competent supervising Site Agent and staff on site throughout the construction period until completion of the Works, and thereafter as may be required during the defects liability period. The Engineer shall give prior approval to the appointment of this supervising Site Agent and key staff and shall have authority to withdraw the approval at any time in accordance with the Conditions of Contract.

All staff and labour employed on the Works shall be employed in accordance with the local labour and employment laws and regulations.

**Works Executed by the Employer or by other Contractors**

The Employer reserves the right to execute, on the site, works not included under this Contract and to employ for this purpose either his own employees or other contractors whose contracts may be either a sub-contract under this Contract, or an entirely separate contract. The Contractor shall ensure that neither his own operations nor trespass by his employees shall interfere with the operations of the Employer, or his contractors employed on such works and the same obligations shall be imposed on the Employer or other contractors in respect of work being executed under this Contract.

**Contractor’s Site Offices, Workshops, Storage and Working Areas**

The Employer shall provide, free of charge, areas of land where the Contractor shall establish the office, housing, workshop, stores, accommodation and camp for himself and his employees. In which case, the Contractor shall provide erect, service and maintain all necessary buildings as offices, housing or workshop/stores for himself, his staff and his employees. These buildings shall form the time of their erection until the completion of the Contract be the property of the Employer and the Contractor shall not demolish or remove any buildings or part of any buildings without the written permission of the Engineer.
All huts, buildings, fixtures and fittings provided by the Contractor shall be removed and the site reinstated at the end of the Contract.

The Employer reserves the right to allocate areas of land less than the Contractor may require. In such case, the Contractor shall make his own arrangement for obtaining the use of the additional areas that he requires.

The location of all the offices, stores and the like shall be to the approval of the Engineer.
6.1.5. Definition and Use of the Site

Definition of the Site

The Site shall include all those areas of land which, being public or private:

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

Use of the Site

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

The Contractor shall at any time remove any vehicle or vessel or any other obstruction under his control that may be required to be removed by the Engineer for any purpose. The Contractor shall move such obstruction promptly on instruction being given.

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

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

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

Possession of the Site

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

Interference with the Works

The Contractor shall not interfere in any way with any existing works, whether the property of the Employer or of a third party, whether or not the position of such works is indicated to the Contractor by the Engineer, except where such interference is specifically described as part of the Works, either in the Contract or in an instruction from the Engineer. He shall also be expected to seek independently the approval from such a 'Third party' in case the need for interference arises.
Material for the Works

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

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

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

Notwithstanding the fact that approval has been given to the source of supply, the Engineer may forbid the use of any materials if, upon delivery, they are found to be defective, or he considers them unsuitable for incorporation in the Works. Such rejected materials shall be removed from the site forthwith.

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

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

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

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

Rejected Materials and Defective Work

Materials or work which, in the opinion of the Engineer, do not comply with the Specification, shall be classified as rejected materials or defective work, and shall be cut out and removed from the Works and replaced as directed by the Engineer. All these rejection of works and materials shall be at contractor’s costs to remedy.

Existing Works and Services

The Contractor shall acquaint himself with the positions of all existing works and services including water mains, storm water drains, cables, legal physical plans and service poles before any excavation is commenced.
The Contractor will be held responsible for any damage, however caused, in the course of the execution of the Works, to such existing works and services.

Such existing works and services, where exposed by the execution of the works, shall be properly shored, hung-up and supported to the satisfaction of the Engineer and of the authority concerned.

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

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

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

The Contractor shall make adequate provision so that when carrying out his work, no interference, damage or pollution is caused to roads and footpaths, or to any mains, drains, and the like or other parts of the Works. Wherever loads have to be carried over ground in which pipes, valves, culverts, and the like are buried, the Contractor shall take all precautions including where necessary, the provision and use of sleepered roads, light gauge railways or other means to prevent damage occurring to such underground works. The Contractor shall not store any plant or materials or spoil heaps over existing water mains, or in such positions that interference with access to the mains, control gates and the likes is created. Approval by the Engineer to the means of protection employed shall not relieve the Contractor of any responsibility in respect of damage occasioned by his operations.

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

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

**Existing Access**

Existing access to lands, property and all other places shall be maintained by the Contractor during the continuance of the Works to the Engineer’s satisfaction.

**Liaison with Police and other Officials**

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

**Water and Power for Use on the Works**

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

The Contractor shall be solely responsible for the location and continuity of the supply of water for use on the Works. Supplies may be derived from rivers and streams, but shall in all cases to be to the Engineer’s approval, and the abstraction of water from any sources shall not interfere with any permanent water supply. The Contractor shall be solely responsible for the transporting of water from its source to the point at which it is required for construction purposes, and in such quantities and quality as to enable the Works to proceed without hindrance due to the shortage of adequate water supplies.
The Contractor shall make his own arrangements for power supplies and shall be solely responsible for the location, procurement and maintenance of a power supply, adequate to meet his obligations under the Contract.

The Contractor shall make his own arrangements for the supply of adequate safe drinking water, electricity and other services to the Permanent Works, Temporary Works and Contractor’s equipment and shall provide and maintain all pipes, cables and fittings which may be necessary to carry such services to his operations.

**Inspection by Engineer during the Defects Liability Period**

The Project shall have a defects liability period of 8 calendar months from the Project commissioning date. Engineer will give the Contractor due notice of his intention to carry out any inspection during the defects liability period. 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 shall take note of all matters and things to which his attention is directed by the Engineer.

**Survey Instruments and Chainmen for the Engineer**

The Contractor shall provide and maintain in first class working order, for the sole use of the Engineer and his staff for the duration of the Contract, the following minimum survey instruments complete with all accessories, tapes, poles, staves, stagings, moulds, templates, profiles, and requisites necessary for checking and setting out, and measurement of the Works. The equipment shall revert to the Contractor at the end of the Contract period.

The survey equipment shall include the following or similar approved as a minimum:

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic level machine</td>
<td>1</td>
</tr>
<tr>
<td>Tripod stand</td>
<td>1</td>
</tr>
<tr>
<td>Levelling staff</td>
<td>2</td>
</tr>
<tr>
<td>Total station minimum error ± 2”</td>
<td>1</td>
</tr>
<tr>
<td>Single Prism and target</td>
<td>3</td>
</tr>
<tr>
<td>Plumbing Pole tripod with bubble</td>
<td>3</td>
</tr>
<tr>
<td>100m measuring tape</td>
<td>2</td>
</tr>
</tbody>
</table>

**Transport for the Engineer**

The Engineer and his staff will be responsible for own transport arrangements.

**Project Sign Boards**

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

Unless otherwise agreed, the signboard shall be in seven sections. Section one shall contain:

**Name of TCML**

- In white lettering on a blue background.
- The second section shall bear the words:

**Names of the Program and Project**

- in white lettering on a blue background.
- The Third section shall bear the words:
Name of the financiers

- in white lettering on a blue background.
- The Fourth section shall bear the words:

Name of the Employer

- in white lettering on a blue background.
- The fifth section shall bear the words:

Name of the implementing agency

- in blue lettering on a white background.
- The sixth section shall bear the words

Name of the executing agency

- in blue lettering on a white background
- The Seventh section (Contractors’ Board) shall bear the words:-

Name of the Contractor

- in blue lettering on a white background.
- Lettering on these boards shall be as directed by the Engineer.
- Further boards may be added with the names of sub-contractors.

Tracked Contractor’s Equipment

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

Fuel Supplies

The Contractor shall arrange for obtaining, storing and distributing all fuel oils required for the completion of the Works. The storage of fuel on site shall comply with the Petroleum Act and or Factories Act applicable in Kenya. Copies of this can be purchased by the Contractor at the Government Printer.

Telephone and Communications

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

Preservation of Trees

No tree shall be removed without prior written permission of the Engineer who will limit the removal of trees to the minimum necessary to accommodate the Permanent Works.

If trees are removed or damaged by the Contractor or his employees, without approval, then the Contractor shall replace such trees.

Replacement of trees shall be with saplings more than two years of age, obtained from a reputable nursery and of a species approved by the Engineer. The Contractor shall plant, water and ensure that the replacement trees are properly established, all at his own cost.
Protection from Water
The Contractor shall keep the whole of the Works free from water and shall be deemed to have included in his Contract Sum all costs for pumping, shoring, temporary drains, sumps and other measures and provisions necessary for such purposes and for clearing away and making good to the satisfaction of the Engineer any damage caused thereby.

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

The Contractor shall be responsible for maintaining qualified fire-fighting crew on the Site at all times as well as maintaining an efficient fire alarm system. The Contractor shall also submit a fire prevention and fire-fighting program for the Engineer’s approval.

The Contractor shall provide suitable and adequate fire-fighting equipment, to the satisfaction of the Engineer, for ready use at all the times in all the Engineer’s site establishment including Contractor’s residential quarters, labour camps and ancillary buildings. These shall be maintained until the completion of the construction and handing over of the works to the Employer.

The Contractor shall comply with laws and regulations regarding fires and with respect to the prevention of fires. No fire may be lit in the dry season without written permission from the Engineer and/or the relevant Authority.

6.1.6. SAFETY PRECAUTIONS

The Contractor’s attention is drawn to the Circular Ref: KA/17/A/2(4) from Factories Inspectorate, Ministry of Labour, Notice No. 79 gazetted in the Kenya Gazette No. 56 (Legislative Supplement No. 38) in respect of the appointment of Safety Supervisors on Building and Works of Engineering Construction. In accordance with this requirement, the Contractor shall appoint a Safety Supervisor who shall be qualified in safety and familiar with the works being performed. The Safety Officer shall ensure that adequate measures and rules for the protection of health and safeguarding against accidents are enforced.

The Contractor shall take all necessary precautions against risks of loss of life or of injury to any person employed on the Works or to employees of the Employer and to the Engineer or to visitors or to persons having good and sufficient reasons to be about the Works, and to this end he shall properly safeguard the Works to the satisfaction of the Engineer.

The Contractor shall at all times comply with any accident prevention regulations and any safety regulations peculiar to the various trades employed on the Works, and any safety regulations published by the Government.

The Contractor shall report promptly to the Engineer all accidents involving the death of or serious injury to any person on the Site or resulting from the Contractor’s operations.

The Contractor shall, at his own expense, educate all his employees on safety precautions based on good practice on site. This shall be done in both English and Kiswahili languages. Safety instructions shall deal with all safety measures including but not be limited to the following; protective clothing, helmets and footwear, use of lifting equipment, precautions against electrical
shock, welding, routine procedures in case of accidents, fires, etc., watchmen, warning notices and barriers, use of drilling equipment and dust suppression and use and storage of explosive. The Contractor is expected to submit a Health Safety Environmental Plan prior commencement of Works.

**Explosives and Fuels**

The Contractor shall make arrangements to transport, store and handle explosives and fuels in a safe manner for protecting the public in accordance with the laws and security regulations in force in Kenya. In this regard, he shall submit a program to the Engineer for approval for the safe handling and storage of explosives and fuels. When approved, the Contractor shall issue a copy to each of his personnel involved with the handling of explosives and fuels.

The Contractor shall obtain all necessary licenses and shall pay all fees and charges in respect of the same as may be necessary for the purpose of moving explosives and fuels from place to place and storing the same, and shall make all applications and obtain approvals from the relevant authorities of the Government of Kenya.

The Contractor shall construct his explosives magazines at locations and in a manner complying with the relevant regulations of Kenya and approved by the Engineer. Detonators and fuse shall be stored in a separate magazine away from explosives. In no case shall they be transported in the same vehicle with explosives.

The Contractor shall provide adequate protective facilities to safely store and to prevent the loss or theft of explosives. Overnight storage of explosives and detonators outside of the magazines will not be permitted. Magazines shall be securely locked when not in use.

The Contractor shall maintain an inventory record of storage and withdrawal of all explosives including detonators. This record shall be available to the Engineer, and the Engineer shall be promptly notified of any loss or theft of explosives.

**Above Ground Fuel Storage Tanks**

The fuel storage tank shall comply with BS 21, 1387, 799, 2594 and 5410 and shall have internal working pressure up to and including 0.4 bars, measured at the top of the tank, and a maximum internal vacuum of 10m bar. Unless otherwise shown on the drawings, the tank shall have a manhole whose centre shall be 450mm from one end. Filling point shall be fitted to the highest point in the tank shell and vent and dip point shall be fitted preferably at the centre of the manhole lid. The Contractor shall supply the dip stick.

The drain point shall be fitted at the lowest point in the tank and flush with the inside of the shell. This shall be at a minimum of 150mm from the ground level. The draw off shall be welded near the base of the tank on the vertical centre-line and at the opposite end to the drain.

The tank shall be suspended from the ground by saddle supports and the bond between the tank and the supports shall be broken by application of bituminous paint on the tank and the saddles. The tank shall be fitted with lifting tugs/hooks of sufficient strength. The location of the tank shall be firm ground with reinforced concrete slab with a provision of catch pits and sumps of sufficient capacities and to the satisfaction of the Engineer. A bund wall shall be provided round the hard standing concrete slab.

The tank shall be earthed in accordance with BS 7430 AND 6651. The earth system shall terminate with copper earth rod in earth test pit.

**Watching, Fencing and Lighting**
The Contractor shall employ competent watchmen to guard the Works both by day and night. Any excavations, material dumps, spoil dumps or other obstructions likely to cause injury to any person or thing shall be suitably fenced off and at night marked by red warning lights.

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

Fences and spoil banks shall be clearly marked at the ends, all corners, and along the length at intervals of not more than 15m by means of white lime washed boards, discs, stones or oil drums during the daytime and by red lamps burning at night. Markers shall be freshly lime washed at regular intervals to ensure that they are white and clean.

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

Soil Conservation

All precautions shall be taken by the Contractor to prevent the erosion of soil from any lands used or occupied by the Contractor for the purpose of the execution of the Temporary Works.

If in the opinion of the Engineer, the Contractor’s operations in areas other than the permanent works caused soil erosion, the Contractor shall undertake soil conservation measures in these areas as directed by the Engineer. The details of the proposed soil conservation measures shall be submitted by the Contractor for the Engineer’s approval prior to the execution of the said works.

All soil conservation measures shall be carried out at the earliest possible time, as approved by the Engineer, to ensure that the required protection is established most effectively during the progress of Works. No separate payment will be made for the soil conservation measures and such costs shall be deemed to be included in the respective unit rates and the Contract Sum.

Dust Abatement

During the performance of the work the Contractor shall carry out proper and efficient measures wherever and as often as necessary to reduce the dust nuisance resulting from his operations. Measures shall include, but not be limited, to installation of dust suppression units on his rock drilling equipment, watering down of excavated material during loading operations, and use of water tankers to sprinkle access roads, disposal areas, etc.

The Contractor shall be held liable for any damage to crops, cultivated fields and dwellings of persons in the neighbourhood of the Works resulting from his operations.

No separate payment will be made for the dust abatement measures and the costs thereof shall be deemed to be included in the respective unit rates and the Contract Sum.

Noise Control

All work shall be carried out without unreasonable noise. Compressors used on site shall be silenced either by using only full silenced models or fitted with effective exhaust silencers and properly lined and scaled acoustic covers all to the design of the manufacturers of the compressor or by the use of effective acoustic screens to enclose the noise source. Pneumatic percussion tools used on Site shall be fitted with silencers of a type recommended by the manufacturers of the
tools. Compressors, silencers or other equipment shall be maintained in good and efficient working order.

No separate payment will be made for noise suppression measures and the costs thereof shall be included in the unit rates and the Contract Sum.

Sanitation

The Contractor shall provide adequate sanitation and refuse collection and disposal facilities complying with state laws and local by-laws for all houses, offices, workshops, and the like, erected on the site, all to the satisfaction of the Engineer.

The toilet facilities provided at the site by the Contractor shall be made available, free of charge, to the employees of the Contractor and any of his sub-contractors.

The Contractor shall warn his employees and sub-contractors that any employee found fouling the site shall be removed from the site immediately in accordance with the Conditions of Contract.

The Contractor shall remove all rubbish and to this end shall provide adequate number of covered garbage bins/containers placed at convenient points around the site establishments. The Contractor shall institute and maintain a regular garbage collection and disposal system. Garbage shall be disposed of by burial or by other means approved by the Engineer.

No separate payment will be made for such sanitary arrangements and all such costs will be deemed to be included in the unit rates and Contract Sum.

First Aid and Medical Services

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

Notwithstanding the minimum requirements prescribed above, the Contractor shall be responsible for the adequacy of all the arrangements made.

HIV/AIDS Awareness

The Contractor shall implement an HIV/AIDS awareness programme for his Personnel.

Pollution

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

Restoration of Drains, Streams, Canals etc

Subject to any requirement of the Works whereby a permanent change is to be effected, all drains, canals, pipes, channels, water-courses or streams temporarily cut through or disturbed by the excavation of the Works are to be restored so that the water flowing in them may continue to flow in as full and free manner as it did before the disturbance.

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

All works shall be constructed to the tolerances shown in Section 8 of these specifications.

Units and Abbreviations

The units of measurement used in these Contract Documents are metric.

The following abbreviations have been used for units and for other words or phrases as indicated.

Abbreviations in the Contract Documents shall have the following meanings:

- mm: millimetre
- m: meter
- km: kilometre
- sq.m, m²: square metre
- ha: hectare
- cu m, m³: cubic metre
- sec, s: second
- hr: hour
- min: minute
- wk: week
- l: litre
- gm: gram
- kg: kilogram
- t: tonne
- No: Number
- nr: Number (in bill of quantities)
- dia: diameter
- max: maximum
- min: minimum
- AD: above datum (levels in metres)
- ch: chainage (distance in metres)
- eo: extra over
- e: exceeding
- ne: not exceeding
- PQ: Provisional Quantity
- PS: Provincial Sum
- Do: Ditto
- fob: free on board
- cif: cost, insurance, freight
- wt: weight
- %: percent
- mh: manhole
- ic: inspection chamber
- HYS: high yield steel
- PCC: precast concrete
- uPVC: uplasticised polyvinylchloride
- GMS: galvanised mild steel
- DI: ductile iron
- SV: sluice valve
- ISO: International Standards Organisation
- KS: Kenyan Standard
- BS: British Standard
- KShs: Kenya Shillings
6.1.7. EARTHWORKS

6.1.8. SITE CLEARANCE AND STRIPPING

General clearance is defined as the clearing, grubbing, removal and disposal of all vegetation, grass, debris, bushes, dense bush, trees, hedges, undergrowth, stumps, roots, shrubs, plants and backfilling of holes left by the removal of stumps and roots.

The widths and lengths over which site clearance is to be carried out shall be instructed by the Engineer. Site clearance over the area of quarries, borrow pits, stockpiles and spoil tips shall be carried out where instructed by the Engineer. The Engineer may give instructions that specific trees, stumps or objects shall not be removed during site clearance operation.

If termite moulds are excavated, the whole of the mould shall be removed.

Where the Engineer instructs that site clearance is required, the entire area shall be cleared and all materials thus cleared shall become the property of the Employer. Unless otherwise instructed, vegetation and perishable materials shall be carted to spoil areas, which spoil areas shall be provided in accordance with requirement of this Specification.

If the Contractor clears the Site in advance of the main Works such that the grass and other vegetation re-grows prior to the main Works commencing at any particular location then any additional, or repeating of, site clearance required shall be at the Contractor’s expense.

When instructed by the Engineer, the Contractor shall demolish wholly or in part, remove and dispose of all buildings, foundations, structures, fences and any other obstructions which have not been designed to remain.

The Contractor shall carefully take down such buildings, structures, fences etc. and the components shall be dismantled, cleaned and stacked in separate heaps. All materials which, in the opinion of the Engineer, are not fit for re-use shall be removed from the site to spoil areas provided in accordance with the requirements of this Specification. All materials, which are re-usable, shall remain the property of the Employer and shall be preserved and protected by the Contractor until removed by the Employer or until the expiry of the Defects Liability Period.

All existing paths, fences, walls, hedges, trees, shrubs, lawn and other features which the Engineer instructs not to be removed or otherwise dealt with, shall be protected from the damage, and any damage which occurs due to the Contractor’s failure to take adequate precautions shall be repaired at the Contractor’s expense.

Stripping work shall basically consist of removal of top soil, grasses, vegetative material to a depth of 150mm below ground level and its disposal to a stockpile. Stripping shall include for removal, stockpiling and for reinstatement or spreading as directed by the Engineer. Measurement and payment of this shall be in square metres, calculated as the plan area instructed by the Engineer.
6.1.9. **Surface Levels**

After the area of any section of the Works has been cleared and after trees have been felled, stumps removed and termite moulds excavated to the satisfaction of the Engineer, but before any other work is commenced, surface levels of the ground shall be taken. The levels shall be taken at spacing agreed with the Engineer. Levels shall similarly be taken on the surface of the ground after the removal of unsuitable overburden prior to placing fill and at the interface between natural ground, rock or artificial hard material layers. The levels shall be agreed with the Engineer. The Contractor shall prepare plans and sections which shall, when finally and mutually agreed, be signed by the Engineer and Contractor as truly representing the configurations of the areas in question at the commencement of excavation or fill construction.

6.1.10. **Definition of Earthwork Materials**

The following definitions of earthworks materials shall apply to this and other Clauses of the Specification in which reference is made to the defined materials:

- “top soil“ shall mean the top layer of soil that can support vegetation;
- “Suitable material“ shall comprise all material which arises from excavations within the Site and which is approved by the Engineer as acceptable for use in the works;
- “Unsuitable material“ shall mean material other than suitable material and shall comprise:
  - material from swamps, marshes and bogs,
  - logs, stumps and perishable materials,
  - material susceptible to spontaneous combustion,
  - clay of liquid limit exceeding ninety (90) and/or plasticity index exceeding sixty five (65).

“Rock” or “hard material” shall be material which cannot be ripped to an average depth of greater than 300 mm by a track type crawler tractor complying with the following:

- in good order complete with all equipment and accessories as supplied;
- rated 300 BHP flywheel power or over;
- with an operating weight of not less than 37.2 tonnes;
- equipped with a hydraulically operated single tine ripper compatible with the tractor used; and
- operated by a qualified operator in accordance with the manufacturer’s recommendations and to the satisfaction of the Engineer.

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

Where excavation contains individual boulders of hard material greater than 0.3m³ each in volume then such boulders shall be classified as hard material.

“soft material” material shall mean all material other than that defined as “rock” or “hard material”.

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Removal of Unsuitable Material

Where directed by the Engineer the Contractor shall remove unsuitable material to the depth as ordered or agreed by the Engineer and shall dispose of it in approved spoil tips.

Excavation General

The Contractor shall prepare a method statement of his proposal for earthworks operation for each particular part of the Works to be constructed at any one time, detailing the location, program of excavation, temporary supports and the placing and handling of the spoil.

The Contractor shall submit for the Engineer’s approval his proposed method statement at least 4 days before his intended date to commence earthworks on each particular part of the Works.

Excavation shall be carried out with the allowances for working space given in the Method of Measurement to the Bill of Quantities, unless otherwise shown as lines, levels and profiles on the Drawings or to such other lines, levels and profiles as the Engineer may direct or approve in writing. The work shall be carried out by the Contractor in such a way as to avoid disturbance to the surrounding ground. Particular care shall be taken to maintain stability when excavating in close proximity to existing works.

The work shall be carried out in a careful manner to ensure that the exposed surfaces are as sound as the nature of the material permits and that no point shall protrude inside the lines shown on the Drawings except as otherwise specified or agreed by the Engineer. In soft excavation, which is to remain open permanently, exposed faces shall be formed accurately to the required slopes and profiles. Excavations in rock where the faces shall remain open permanently shall be trimmed so that no point protrudes within the required profile.

The Contractor shall examine all excavated faces regularly and shall remove all insecure material or materials resulting from any falls. Where instructed in writing by the Engineer, the Contractor shall wash down exposed surfaces of excavated rock for inspection.

The Contractor shall dispose of all material arising from excavations. If it is suitable and required for the Permanent Works it shall be placed directly in such Works or set aside for use as and when required in suitable approved dumps, otherwise it shall be removed to tips provided by the Contractor unless otherwise provided or directed by the Engineer.

The Contractor shall be responsible for keeping all excavations free from water from whatever cause arising and shall provide such pumping capacity and other measures as may be necessary for this purpose. The Contractor shall make good any damage that may result from his failure to keep the excavations free from water.

All excavation shall be carried out with care and the method and Contractor’s equipment to be used in execution thereof shall be to the satisfaction of the Engineer. The Contractor shall be responsible for the safety and security of all excavations at all times during the execution of the contract and where necessary shall provide timbering, shoring or other measures required by the Engineer to prevent movement or loss of ground outside the boundaries, settlement of or damage to property, or injury to persons. The Contractor shall make good any damage to structures, services or other properties caused by such movement, loss of ground and settlement. The Contractor shall also take precautions to route his equipment in such a manner as to minimise the likelihood of slips occurring due to vibration or surcharge from the working or movement of heavy machinery.

The Contractor will be permitted, subject to the approval of the Engineer, to adjust side slopes of excavations in soft materials which are to remain open temporarily in preference to shoring or strutting. However no payment shall be made for extra excavation volume as a result of these measures.
The Contractor shall notify the Engineer without delay of any permeable strata, fissures or unusual ground encountered during excavation.

Unless otherwise specified, the Contractor shall keep the excavation clear of water during construction and, in the case structures being constructed in ground water for such further period as may be necessary to avoid the submergence of concrete within the period as specified hereafter. It shall be considered whether the adopted dewatering scheme allows the sides of the excavation to remain stable at all times and that excessive heave or rupture of the base does not occur. Furthermore, care should be taken to prevent that the return of the groundwater results in collapse of soils having sensitive structure e.g. loose sand.

The method of keeping excavation clear of water, dewatering and disposal of water, shall be subject to the approval of the Engineer. Where a structure is subject to uplift the Contractor shall reduce the ground water pressures so that the structure is stable for the whole period of the construction. The Contractor shall ensure that sufficient stand-by plant is available on Site at all times to avoid any interruption to continuous dewatering.

**Hand Trimming at Formation Level**

Where the formation level of any excavation is to receive concrete or compacted fill, the final 0.15 metres of the excavation shall be trimmed by hand, or by such other method as may be approved or ordered by the Engineer, after removal of any slurry and loose material and immediately before placing the concrete or fill.

The formation level shall be carefully levelled or shaped as required. The Contractor shall report to the Engineer when excavations are ready to receive pipes or concrete foundations and shall not proceed with pipe laying, concreting or other works until they have been passed and approved by the Engineer. Any pipe laying, concreting or other work carried out without prior approval of the Engineer shall be removed immediately at the Contractor’s expense.

**Filling not to Endanger Structures**

The Contractor shall arrange the timing and rate of placing of backfilling or of filling to structures in such a way that no part of the Works is over stressed, weakened, damaged or endangered. The layers of material shall be so placed as to maintain adequate drainage and to prevent accumulation of water. In particular, the placing of material around concrete structures shall commence only after they have been completed and have attained their full specified strength. The material shall be placed so as to exert a uniform pressure around the structures. Regardless of the method of backfilling adopted the Contractor shall ensure that backfilling to excavations is carried out to the satisfaction of the Engineer. The Contractor shall take all necessary precautions to ensure that no damage is caused to the Permanent Works or to adjacent structures.

**Filling of Excavations beneath Roads**

Excavations for pipelines laid under site roads and public roads shall be backfilled above the pipe fill surround with selected gravel or crushed stone road base material.

Filling shall be built up evenly over the full width and compacted in layers not exceeding 200 mm in depth at the optimum moisture content. The moisture content of backfill material may require adjustment to that required to attain maximum density. Backfill material, which contains insufficient moisture to obtain the desired compaction, will require the incorporation of additional water by the use of approved sprinklers and mixing before laying.

Layers more than 300 mm below road formation shall be compacted to 90% of the maximum dry density determined according to ASTMD1557 Method D or to BS1377 Test 12 or 14. Layers less than 300 mm below road formation level shall be compacted to 95% of the maximum dry density determined according to the aforementioned standard methods.
The Contractor shall ensure that the backfill material laid immediately adjacent to a structure concrete wall or thrust block is well compacted. Hand operated vibrating plate compactors vibro-tampers or power rammers shall be used. In other cases compaction shall be carried out by vibrating compactors, smooth wheel or pneumatic tyre rollers of types approved by the Engineer.

Excavations for pipelines laid otherwise or for other structures beneath the carriageways where mechanical compaction cannot be applied due to narrow space shall be backfilled with lean mix concrete. This concrete shall comprise proportions by weight of:

- 1 part of cement
- 3 parts of sand
- 6 parts of aggregate with a maximum size of 40 mm.

**Reinstatement of Public Highways**

Reinstatement of public highways shall be carried out as soon as is practical after completion of the Permanent Works and before the section of the road or pavement is re-opened for public use. Reinstatement shall be maintained by making good any subsidence, shrinkage, defect, imperfection or fault during the Defects Correction Period. The types and thicknesses of the materials used in the road reinstatement shall be, as a minimum, as those of the existing construction or as otherwise instructed by the Engineer, to suit the requirements of the relevant Authorities. Reinstatement where not specifically required by the Authorities shall comprise an additional depth of sub-base material as instructed by the Engineer. Original surface materials may be placed by hand with the wearing course upper most. The method of placing and compacting of materials shall be similar to that for road base construction, to the same surface tolerance, and to suit levels of the surrounding undisturbed road or pavement.

Only materials approved by the Engineer shall be used for making good any defects.

**Levelling of Areas**

Areas around or on top of structures shall be levelled to the required levels as indicated on the drawings or instructed by the Engineer. The Contractor shall the due precautions to prevent any damage to the structures during the levelling. The levelling of areas around structures shall be carried out by approved methods. Any damaged item shall be replaced or repaired at the Contractor’s expense and to the satisfaction of the Engineer.

**Sheeting and Bracing**

The Contractor shall be responsible for the design, installation and maintenance during construction, and where appropriate, removal of all support Works needed for trenches and other excavations. The Contractor shall submit to the Engineer for approval, details of his proposal for excavation support which details shall include such drawings, calculations or other explanatory matter as the Engineer may require, but such approval shall not relieve the Contractor of his responsibilities under the Contract. No excavation work may proceed until the Engineer’s approval has been given to the Contractors proposals.

The Contractor shall not remove temporary Works supporting the excavations until in the opinion of the Engineer the Permanent Work is sufficiently advanced to permit such removal, which shall be executed under the personal supervision of a competent foreman.

Where the removal of excavation support Works is considered by the Engineer to endanger existing structures thus making them liable to subsidence damage, the Contractor shall leave such support Works in place, removing only the minimum necessary to allow the reinstatement of the surfaces.
6.1.12. **ADDITIONAL SITE INVESTIGATION**

**General**

In case of need the Contractor shall conduct additional investigations at his own costs. The methods shall involve generally available commercial tests performed according to generally accepted or standard procedures. In case investigations of a more specialized nature are required, these shall be undertaken where necessary, and test procedures and test interpretations shall be given. Laboratory tests shall be carried out in a laboratory approved by the Engineer.

The geotechnical investigations shall provide all data concerning the ground and the ground water conditions at and around the construction site necessary for a proper description of the essential ground properties and a reliable assessment of the characteristic values of the ground parameter values to be used in design calculations. The following items should be considered for inclusion in the design investigation of the relevant ground:

- Geological layers of the ground
- Strength properties of all relevant ground
- Deformation properties of all relevant ground
- Pore pressure distribution through the ground profile
- Permeability conditions
- Possible instability of subsoil
- Compaction properties of the ground
- Possible aggressiveness of the ground and the ground water
- Possibility of ground improvement
- Frost susceptibility

Should the Engineer consider that the investigations undertaken by the Contractor remain insufficient for detailed design of any part of the Works, the Contractor shall undertake further work, and/or employ a specialist Site Investigation firm as instructed by the Engineer.

Additional site investigations, whether or not ordered by the Engineer shall be carried out in accordance with international standards specifically BS1377, BS5930 and BS8004, unless otherwise specified, and will be paid for at rates agreed to by the Engineer. The fieldwork to be carried out by the Contractor may comprise but need not be limited to or exclude other field works:

- Vertical test borings
- Sampling and laboratory tests
- Penetration tests (SPT and/or CPT)
- Vertical plate load tests
- Permeability tests
- Ground water table and ground water quality determination

The site investigation work shall be carried out using modern methods and equipment and by fully competent staff under the supervision of a qualified Engineer. The equipment employed shall be such as to provide the necessary data.

**Soil Investigation Report**

If required by the Engineer, the Contractor shall submit to the Engineer a Soils Investigation Report incorporating a record of all the investigation work carried out by him. The Report shall include boring logs, records of field and laboratory tests, records of water level observations and recommendations as to the bearing capacity and deformation properties of the soil and water inflow. Five copies of this Report shall be submitted to the Engineer within one month of completing the field work. Laboratory tests shall be carried out in a laboratory approved by the Engineer.
Design of Structures

This section outlines the requisite measures to be taken by Contractor for works that he may need to design for the Engineer’s approval; the Contractor shall use the data in the documents and the results of the Additional Site Investigations to design in detail every aspect of the Works, permanent or temporary, that is affected by the subsoil. Notwithstanding requirements outlined in this section the design by the Contractor where needed shall be entirely the Contractors’ responsibility to the approval by the Engineer.

Limit States

For spread foundations (1), pile foundations (2), retaining structures (3), embankments and slopes (4) a list of Limit States to be considered shall be compiled. The following limit states shall be considered:

- loss of overall stability (1,2,3,4)
- combined failure in ground and in structure/structural element (1,2,3)
- bearing resistance failure (1,2)
- excessive settlements (1,2)
- excessive heave (1,2)
- unacceptable vibrations (1,2)
- failure by sliding (1)
- structural failure due to foundation movement (1)
- uplift or insufficient tensile resistance of the pile foundation (2)
- failure in the ground due to transverse loading of the pile foundation (2)
- combined failure in the ground and in the pile foundation (2)
- failure of a structural element such as a wall, anchor, wale or strut or failure of the connection between such elements (3)
- movements of the retaining structure which may cause collapse or affect the appearance or efficient use of the structure, nearby structures or services which rely on it (3)
- unacceptable leakage through or beneath the wall (3)
- unacceptable transport of soil grains through or beneath the wall (3)
- unacceptable change to the flow of groundwater (3)
- failure due to internal erosion (4)
- failure due to surface erosion or scour (4)
- failure due to hydraulic uplift (4)
- deformations (including those due to creep) of the embankment or slope and their foundations which cause structural damage, loss of serviceability or failure in adjacent structures, roads or services (4)
- deformations of the embankment or slope, including those of creep, which cause loss of serviceability (4)
- surface erosion (4)

Within the Serviceability Limit State (SLS) for shallow foundations, the progress of settlements through the various construction stages and throughout the specified lifetime of the structures shall be investigated. The Contractor’s design shall verify acceptable deformations at all stages and throughout the design lifetime of the project.

Retaining walls shall be designed to limit deformations at all stages of construction, and if permanent throughout the design lifetime of the project. Where retaining structures are in the immediate proximity of buildings, structures, roads, pipelines or utilities they shall be braced and dimensioned to sustain the different horizontal pressure resulting from vertical and possible horizontal loads.
Durability

In geotechnical design the internal and external environmental conditions shall be estimated at the design stage to assess their significance in relation to durability and to enable provisions to be made for the protection or adequate resistance of the materials.

Ground treatment

Any ground treatment proposed by the Contractor to improve the bearing capacity and/or settlement characteristics of the soil must be supported by a full method statement and design calculations with a statement of the minimum performance to be achieved. Where directed by the Engineer the Contractor shall carry out a field trial of the proposed treatment to demonstrate that it meets the stated performance criteria.

Geotechnical Design Report

The Contractor shall establish a set of geotechnical design parameters, which take into account the volume of soil involved in the particular analysis. The characteristic value for any material shall be used for both SLS and ULS analyses.

As a part of the Contractor’s design the assumptions, data, calculations and results of the verification of safety and serviceability shall be recorded in a Geotechnical Design Report.

The Geotechnical Design Report shall include a plan of supervision and monitoring, as appropriate. Items that require checking during construction shall be clearly identified in the report. When the required checks have been carried out during construction, they shall be recorded in an addendum to the report. An extract of the Geotechnical Design Report containing the supervision, monitoring and maintenance requirements for the completed structure shall be provided to the Employer.

Blasting

The Contractor shall not be permitted to use explosives for rock excavation without the approval of the Engineer. The Contractor shall only employ suitably qualified and experienced personnel to manage and supervise blasting operations. For each blasting operation, the Contractor shall submit to the Engineer for approval a statement detailing the type of explosives to be used, method of transport, storage, blasting procedures, safety precautions to be observed and the names and experience of the personnel who will supervise the work. Notwithstanding the Engineer’s approval, the Contractor will be responsible for the blasting operations and shall accept full and absolute liability for any claims resulting either directly or indirectly from the use of explosives on the Site.

When necessary, blasting for clearing boulders and/or rock masses will be permitted only on written approval of the Engineer and when proper precautions are taken for the protection of all persons, the Works and public and private properties. Blasting shall be carried out in a controlled manner and to the required depth, amount and extent necessary and only with explosives of such quantity and strength and in such locations as will not structurally damage the material to be blasted outside the prescribed limits.

Any damage to the Works or properties arising from the blasting shall be repaired by the Contractor to conform to the condition existing prior to damage. Before any blasting is carried out, the Contractor shall ensure that adequate measures that are necessary for the safety and protection of persons and property against injury or damage has been provided and warning signs and signals has been installed. all to the satisfaction of the Engineer and other authorities concerned with safety and public order.

Notice of Commencement

The Contractor shall give to the Engineer written notice of his intention to commence the clearing and grubbing and/or blasting operations. The works shall not be commenced until written approval has been received from the Engineer. The Contractor shall ensure that all clearing,
grubbing and blasting are carried out far enough in advance of other construction operations within the relevant areas in order to avoid delays.

The Contractor shall supply and install sirens and loudspeakers systems, so that adequate warning may be given to all persons who may be endangered when explosives charges are to be fired. The Contractor shall ensure, prior to discharging explosives, that the area to be blasted is clear of all workmen, residents, pedestrians etc. In addition he shall post flagmen on each of the roads entering the said area so as to stop and prevent any traffic from entering into the area until “all clear” notification is given.

During thunderstorms and other electrical disturbances, no charging and firing will be permitted.

The blasting operations shall comply in every respect with the regulations and laws covering the use of explosives and the Contractor shall be responsible for obtaining all necessary permits.

**Excavation beyond Line or Level**

The extent of excavations shall be the minimum necessary or practicable in the opinion of the Engineer for the construction of the Works.

If from any cause whatsoever excavations are carried out beyond their true line and level other than on the instructions of the Engineer, the Contractor shall make good to the required line and level with the appropriate grade of filling to be contained in the true excavation, or with concrete or other approved material in such a manner as the Engineer may direct.

**Approval of Excavation**

When excavations have been taken out accurately to the profiles or dimensions required for the work the Contractor shall inform the Engineer who shall carry out an inspection of the excavation. If, after his inspection the Engineer requires additional excavation to be carried out, the Contractor shall do so to such new profiles or dimensions as the Engineer may direct.

**Excavation for Structures**

Open excavation to form a foundation for a structure shall be carried out to the lines necessary to permit the proper construction of the structure to the approval of the Engineer.

Where a structure is to be founded on soft ground, the excavation shall be taken down until the required formation is exposed and prepared to the approval of the Engineer. Where concrete has to be placed on a soft foundation, the Engineer may direct that a blinding layer of lean concrete be placed beneath the structural concrete immediately after completion and approval of the excavation, or require the Contractor to remove the last 100mm of excavation immediately prior to placing the concrete. If foundation conditions are very soft the Engineer may instruct that additional material be excavated and replaced with compacted gravel or hardcore.

Where a structure is required to be founded on rock but is not required to penetrate into it, all soft overburden shall be removed and the surface of the rock cleared of any loose material by barring and wedging. Where the foundation is required to penetrate into the rock, excavation of the rock may be carried out by blasting but in such a manner as to prevent the shattering of the rock which is to remain. The Engineer may direct that the last 300mm of rock be left and be removed by barring and wedging or by the use of approved pneumatic tools so that the exposed surface is sound.

No excavations with battered sides will be permitted in public highways, private gardens or within 30 metres of any building or other structure. In the event of the Contractor adopting the method of excavation with battered sides his obligations for providing supports.

The Contractor shall report to the Engineer whenever excavations are ready to receive concrete. No concrete shall be placed in the foundations until the Contractor has obtained the Engineer’s agreement that a secure foundation has been reached and that the excavation has been carried out to the lines and levels required.
Excavation for Fill Foundation

Foundations for embankments shall be excavated to the depths or to the soil or rock grade indicated on the Drawings or described in the Specification. The suitability of each part of the foundation for placing fill thereon shall be determined by the Engineer. No fill shall be placed before acceptance of the foundation by the Engineer and recording of the geology.

Where specified in the Drawings or Specification or directed by the Engineer, seams and other defects below the general level of the foundations shall be excavated and filled or covered with materials including mortar and concrete to the satisfaction of the Engineer before fill is placed thereon.

Where embankments are to be constructed on sloping ground, and where shown on the Drawings, benches shall be excavated in the foundations to the dimensions shown on the Drawings.

Except where specifically permitted by the Engineer all foundations for fill shall be kept free of water when placing fill thereon.

Earth foundations shall have the top 150mm sufficiently moistened and, if necessary, harrowed or scarified and compacted to at least ninety five per cent (95%) of the maximum dry density as determined by the AASHTO T99. Material too wet to be so compacted shall, as directed by the Engineer, be allowed to dry, harrowed or scarified to reduce the moisture content to the required amount and then be re-compacted.

Trench Excavation

Trench excavation shall be performed by the use of hand tools and approved mechanical equipment, in such manner as to minimise disturbance of the sides and bottom of the excavation.

Trenches for pipes shall be excavated to a sufficient depth to enable the pipe and the specified joint, bedding, haunching and surround to be accommodated. Unless otherwise stated, the width of the trench shall be equal to the nominal diameter of the pipe plus 700 mm.

The Contractor shall fill any over excavation beneath the pipe or bedding at his own cost with well rammed selected general excavation material as per requirement of this Specification. The Contractor shall dispose of surplus excavated material not required for backfill to spoil tips.

The sides of trenches shall be adequately supported at all times. Alternatively where the Contractor has to excavate the trenches in open cut the Contractor shall ensure that the side slopes of the excavation are sufficient for stability.

Where rock or boulders are present in the sides or base of a trench in which a pipe is to be installed, the trench shall be trimmed so that when the pipeline is laid, no projection of rock comes within 200mm of the outside of the pipe at any point. The over excavated portion shall be backfilled as set out in this Specification with approved granular material at the Contractor’s expense.

The Contractor shall be entirely responsible for the sufficiency of all temporary supports and side slopes to the excavations. The excavation shall be carried out in such a way as to maintain the stability of all roads and other adjacent structures or works.

Channel Excavation

The excavation of all channels shall be executed in such a manner as to ensure that the stability of side slopes is not endangered. Should slips or undercutting occur for reasons attributable to the Contractor’s negligence or method of working, the Engineer will give instructions for remedial works to be carried out by the Contractor at the expense of the Contractor.

Where channels are to be reshaped, cleared and trimmed, the width, depth, side slopes and centre line radius shall be as shown on the Drawings. The Contractor shall clear all weeds and growth from existing channels and grade the beds to required levels. The area of waterway shown is the
minimum required and sides of channels shall be trimmed to the required slope so as to provide widths not less than those shown on the Drawings.

Any channels, streams, drains or pipes taking water to or from cultivated land shall be diverted so as to maintain their flow before being moved or broken into unless express permission to the contrary is given by the Engineer. All diversions and their subsequent reinstatement are to be carried out to the satisfaction of the Engineer. The Contractor shall be deemed to have included the cost of dealing with this in his rates.

Side banks of channels shall be trimmed to a neat appearance and even surface.

In the construction of channels and embankments a local balance of cut and fill shall be maintained as far as possible unless the cut is unsuitable material or is specified in the drawings that the fill should be imported. A deficiency of fill material shall be made up by bed borrow or gleaning. Surplus material, if suitable and approved by the Engineer may be used for an increased width of embankment otherwise it may be spread at the toe of the embankment or placed on spoil tips as directed by the Engineer.

Where required the Contractor shall control the rates of filling and draw-down of water in channels so as not to endanger the stability of earthworks.

**Slips, Falls and Excess Excavation**

Every precaution shall be taken by the Contractor to prevent slips and falls of earth and other material in the excavations. In the event of slips or falls occurring or in the event of excavation being made in excess of the minimum necessary or practicable for the construction of the Works the voids so formed shall be filled. In all cases where the voids so formed when backfilled would provide support for the permanent Works or adjacent structures and services then such voids shall be filled solid with concrete Class E at the Contractor’s expense. In all other cases the voids shall be packed with selected excavated material or approved fill material and thoroughly compacted to the Engineer’s approval.

In the event of any trench for pipelines exceeding the maximum allowable widths as specified or shown on the Drawings the Engineer will order the restoration of the trench width or the use of an alternative bedding material or such other remedial action as in his opinion is necessary. The Contractor shall then carry out the measures so ordered by the Engineer and shall have no claim against the Employer for any additional costs resulting from such instructions.

**Disposal of Excavated Material**

Material obtained from excavations which are suitable for forming embankments or other fill areas shall be placed directly in the Works or set aside for use as and when required in suitable approved dumps. Any such suitable material which may be surplus to the total requirements of the Works shall be taken to spoil in tips provided by the Contractor, unless otherwise provided or permitted by the Engineer.

If the Contractor is permitted to remove suitable material from the site to suit his operational procedure or to take such material for purposes other than forming embankments or other fill areas, he shall make good any consequent deficit of filling arising there from, unless otherwise agreed by the Engineer.

All material not suitable for embankments or other filling shall, unless otherwise directed by the Engineer, be taken to separate spoil tips provided by the Contractor.

The cost of disposal of surplus or unsuitable materials shall be deemed to be included in the respective unit rates for the excavation work and the Contract Sum.

**Spoil Tips**
The Contractor shall be responsible for the provision and sufficiency of tips for the permanent disposal of spoil and shall select their location within the general areas indicated on the Drawings or as otherwise designated or approved by the Engineer. The Contractor shall submit his proposals for the locations and detailed treatment of tips to the Engineer for approval, which will in no way relieve the Contractor of his responsibilities and obligations under the Contract, whether or not locations are shown on the Drawings or otherwise designated.

No spoil shall be permanently deposited elsewhere than on approved spoil tips unless approved by the Engineer. Spoil tips shall be built up and compacted and trimmed and regulated to levels and profiles approved by the Engineer. Where directed by the Engineer, upper surfaces and slopes of the tips shall be soiled to specified thickness.

**Borrow Pits and Quarries**

Where there may be an insufficiency of suitable material from excavations for filling or is specified on the drawings, the Contractor shall obtain such material from borrow pits or quarries approved by the Engineer where the filling is required for Permanent Works. The Engineer may propose a borrow pit for exploration by the Contractor, however, it shall be entirely the responsibility of the Contractor to locate suitable sources of borrow material for fills.

The Contractor shall investigate the site or sites which they propose to open up and shall provide full and detailed information by means of boreholes, trial pit testing reports, etc. to satisfy the Engineer that the quality of the material meets Specification requirements and that the quantity is adequate for the Works.

Notwithstanding the foregoing, the Engineer shall have the right to order the Contractor to obtain materials from a particular designated source or by widening cuttings for permanent works beyond specified profiles.

The Contractor shall provide equipment and make all other arrangements for excavating, loading and transporting material of the specified quality for completion of the Works in accordance with the agreed programme. These provisions shall include where necessary for any operations involving selection, stockpiling and handling of suitable material, the disposal of unsuitable material or overburden and any other operations which may be found necessary due to the nature and disposition of the excavated materials.

The pits and quarries shall be operated in a safe manner provided with ample drainage leaving no stagnant pools. On completion of the Works they shall be left free-draining and in a tidy and regular state. All loose material shall be barred down and no face shall be left overhanging except with the approval of the Engineer.

The removal of vegetation, topsoil and overburden at the borrow pits shall not be paid for separately. Contractor will be deemed to have allowed for the costs elsewhere in his rates. The same applies to any works required to access the borrow pits.

The rate for fill shall include for the supply of material inclusive of extraction, loading and transportation to Site for a maximum haulage distance of 30 km, one way. Where suitable borrow pit is not available within this distance, over haul will be paid for. Measurement shall be the product of the volume of compacted material in situ and the haulage distance in excess of 30 km, one way, along the shortest route, as determined by the Engineer. The Contractor shall be responsible for the maintenance of this selected route, at his own cost.

**Earth Filling**

Material for filling shall be obtained from approved sources and shall not contain more than 1% of vegetation matter, rubbish and humus material and shall contain no boulders or rock of a size greater than half the compacted thickness of the layer. No material shall be used which is so uniformly graded that D60 divided by D10 is 4 or less, where D60 and D10 are sizes such that 60% and 10% by width of the particles are finer than D60 and D10 respectively.
Unless otherwise specified the fill material for the stilling basin embankments shall meet the following requirements:

- Plasticity Index (PI) of more than 40%.
- Permeability of less than $1 \times 10^{-6}$ mm/s
- CBR after 4 days soaking compacted to 100% of AASHTO T99 at optimum moisture content of not more than 3%.

Prior to commencement of filling, the Contractor shall submit in writing to the Engineer for approval his proposals for carrying out the work such that the optimum use may be made of excavated material as far as possible. The proposals shall include the compaction equipment and methods for adjusting the moisture content of the material which he intends to use. No filling shall be carried out until the proposals and the material intended to be used are approved by the Engineer.

Fill shall be placed in layers not exceeding 150mm compacted thickness, each layer being scarified and thoroughly compacted to obtain a dry density not less than 95% of the maximum dry density as determined by AASHTO T99. The moisture content shall be adjusted as necessary to achieve the compaction standards.

The Contractor shall take all necessary measures to prevent any damage or defects to the Works which may be caused by settlements, slips or falls of embankments and shall make good such damage or defects as may occur to the satisfaction of the Engineer, all at his own cost.

Any instability of any adjacent excavation resulting from the embankment not being formed to the lines, levels and profile shown in the Drawings or as ordered by the Engineer will be the responsibility of the Contractor. Where double-handling of excavated material is necessary, the Contractor will be responsible for the temporary disposition of the material such that it does not endanger the stability of the excavation.

**Backfilling of Structural Excavations**

Backfilling of structural excavations shall be carried out with excavated material selected or approved by the Engineer. The material shall be placed in layers not exceeding 150mm compacted thickness or such other thickness as the Engineer may approve or direct and shall be compacted as specified in Clause 2.16.

When material is filled up to or over any structure, the filling shall be brought up equally on each side or as otherwise agreed by the Engineer so that no unequal pressures likely to cause damage to the structure are applied.

**Filling under raised foundations**

The material to be used as filling under raised foundations shall consist of suitable material obtained from adjacent excavations or approved borrow sources, and shall be placed in layers not exceeding 100mm compacted thickness. The material shall be compacted in accordance with the technical specifications mentioned above.

**Frequency of Testing**

Testing will be carried out as instructed by the Engineer with the following being the minimum testing frequencies:

Field Dry Density Moisture Content Test. Every $500m^2$ of compacted fill layer placed or at least 2 tests in any one length of compacted fill, whichever is greater.
Particle Size Sieving Analysis, Atterberg Limits and AASHTO T99 test. Every 1000 cubic meters of compacted fill or at least 2 tests in any one length of compacted fill, whichever is greater.

The apparatus for these tests and the manner in which they are carried out will be as described in BS 1377/1990 and AASHTO T99. All results of these tests shall be submitted to the Engineer with the least possible delay.

Granular Bedding

Granular bedding material shall comply with BS EN 12620 for aggregates within the sizes range 14mm to 5mm. Material complying with BS EN 12620 except in respect of grading may be used provided that it has a maximum size not exceeding 14mm.

Grassing

Before planting grass, all areas to be planted shall be cleared of stones and any other non-organic matter. Planting shall be carried out when directed, and the Contractor shall keep all grassed areas watered and weed free until the expiry of the Defects Liability Period. Any areas which have failed shall be replanted by the Contractor, at his own expense.

Slopes and Batters

Where a slope is given in the Specification or on the Drawings as a ratio of vertical and horizontal components, it shall be understood that the first component is vertical in all cases example. a “slope of 1 in 2” will mean one vertical in two horizontal and a “batter of 4 to 1” will mean four vertical to one horizontal. This meaning will be attributed to all other terms such as “inclination” and “gradient”.

Trial Pits

The Contractor shall excavate, maintain and afterwards refill any trial pits ordered by the Engineer. The sides of the pits shall, where deemed necessary by the Engineer for safety purposes, be supported by sheeting or boarding with adequate framing. A ladder shall be provided for inspection purposes.

Sheet Piling

Where shown on the drawings or instructed by the Engineer the construction of sheet piling shall comply with the codes of practice for earth retaining structures, BS 8002: 1994.
6.1.13. CONCRETE WORKS

Concrete General

Concrete shall consist of cement, graded aggregate and water carefully proportioned, thoroughly mixed, placed and compacted as specified.

The Contractor shall obtain formal approval from the Engineer before pouring any concrete for the permanent works. The Engineer shall allow concreting after ascertaining the required lines and levels, suitability of formwork, availability of required equipment and labour, proper fabrication and spacing of the steel bars and quality and quantity of cement and aggregates.

Cement

Cement for use in the permanent works shall be Ordinary Portland Cement from an approved manufacturer and shall be type CEM I 32,5N complying with BS EN 197-1. Where sulphate-resisting cement is specified, it shall comply with BS 4027.

All cements shall be certified by the manufacturers as complying with the requirements of the specification. Before orders are placed the Contractor shall submit details of the proposed supplier(s) together with such information on the proposed methods of transport, storage and certification so that the Engineer may satisfy himself that the quantity and quality required can be supplied and maintained throughout the construction period. Where necessary the Engineer may require representative samples of the proposed cement to be taken and forwarded to a nominated laboratory for analysis and testing before the source is approved.

No cement shall be used in the Works until deemed satisfactory by the Engineer.

Supply of Cement

Cement shall be obtained from one manufacturer unless otherwise authorised by the Engineer. Should the use of cement from different manufacturers be authorised, the different supplies of cement shall be stored separately and shall not be mixed.

The Contractor shall supply to the Engineer copies of the manufacturer’s test certificates certifying that each consignment of cement has been tested and analysed, and that the results comply in all respects with the above standards. Each certificate shall state clearly the date of despatch and the number of bags despatched in each consignment.

Bagged cement shall be delivered in sealed 50kilogrammes sacks. Each bag shall be marked with the parcel number of the cement contained. Bagged cement shall be transported so that at no time is it exposed to damp and so that moisture cannot be absorbed from the atmosphere. Cement in bulk shall be transported in totally enclosed water tight and sealed containers.

If cement is obtained from an intermediate agent, such agent’s arrangements for transporting and storing cement shall be to the approval of the Engineer.

Storage of Cement

The Contractor shall provide sufficient storage capacity on Site to ensure that his anticipated programme of work is not interrupted due to lack of cement. Factors outside the Contractor’s control such as transport, weather conditions, holidays and breakdowns shall be taken into account.

Cement delivered to the Site in bulk shall be stored in dry, well ventilated weather proof silos or bins which shall be self-clearing. Cement delivered to the Site in bags shall be stored in dry, weather-proof
sheds which shall have floors of damp proof construction raised at least 150mm above the surrounding ground.

Cement of different consignments shall be stored separately and consignments shall be used in the same order as they are delivered to the site. No cement shall be stored on the site for longer than three months from the date of despatch by the manufacturer. If not used within that period, the cement shall be removed from the site.

Any bag of cement which is damaged or found to contain cement which has set or partly set, shall be discarded and not used in the Permanent Works.

**Testing of Cement**

Cement shall be tested by the manufacturer. If the manufacturer’s test certificate is not made available, representative samples shall be taken from different bags or containers of each consignment. They shall be suitably packed and sent to an approved laboratory for testing to prove the cement’s compliance with the specified standards.

The Engineer may require cement to be tested after its delivery to the site. Any cement which has been in store at the site for longer than one month shall be re-tested.

The Engineer may take samples of cement from cement bins or bagged cement, from a parcel of cement after its delivery to the site, or from a parcel of cement which has been stored at the site for longer than one month.

In addition to the manufacturer’s tests the Engineer may require the following tests to be carried out to BS EN 196-3:

- Comprehensive strength;
- Soundness.

Any cement which fails to meet the specified requirements shall not be used in the Permanent Works.

**Aggregate for Concrete**

**General**

Aggregates for concrete shall comply with BS EN 12620, and shall be obtained from a source or sources approved by the Engineer and shall be transported and stored in such a manner as will prevent:

- Contamination of the aggregates from the ground, rubbish, vegetation, dust or any other foreign material.
- Segregation.
- Intermixing of aggregates of differing characteristics.

Before aggregates from each source are approved for use in the Permanent Works, tests shall be carried out at an approved testing laboratory on representative samples submitted by the Contractor to check that the aggregates comply with the requirements of the Specification.

During concreting operations, tests shall be carried out to check that aggregates delivered for use in the Permanent Works comply with the requirements of the Specification.
Sampling and testing of aggregates for concrete shall be carried out in accordance with the requirements of BS 812 except where described otherwise.

Moisture contents of aggregates shall be determined as the moisture content of the aggregate compared with that of the aggregate in the saturated surface-dry condition. Specific gravities of aggregate shall be determined on aggregate in the saturated surface-dry condition.

Aggregates shall be stored on a clean, free draining surface. The various types and sizes of aggregates shall be kept separate from each other and each stockpile shall be kept as large as possible to maintain a reasonably uniform content in the aggregate.

**Fine Aggregates**

Fine aggregates shall be clean and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with BS EN 12620. All the material shall pass through a 5 mm BS sieve. In order to achieve an acceptable grading, it may be necessary to blend materials from more than one source.

As an alternative, fine aggregate for mortar only shall comply with BS 1199 and 1200. The fine aggregate shall not contain iron pyrites or iron oxides. It shall not contain mica, shale, coal or other laminar, soft or porous materials unless the Contractor can show by tests on finished concrete as set out in BS EN 12390 that the presence of such materials does not adversely affect the properties of the concrete.

The proportion of clay, silt and other impurities passing a 75 microns BS sieve shall not exceed three per cent for natural or crushed gravel sand or 15 per cent for crushed rock sand. The shell content shall not exceed 15 per cent by weight.

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.05 per cent by weight expressed as chloride ion when tested as set out in BS 812, subject to the further restriction given in the note on total chloride content in previous section.

Soundness: After five cycles of the test set out in ASTM C88-76, the aggregate shall not show a weight loss of more than 10 per cent.

Samples taken from the fine aggregate shall pass the colour test for organic impurities described in previously.

Tests on fine aggregates shall be carried out daily or as required by the Engineer on site during concreting operations as follows:

- Sieve analysis
- Moisture content. An approved “rapid” test may be used for this test.
- Percentage of material passing a 75 microns BS sieve by the Field Settling Test, checked when necessary by the Decantation Method.
- Test for organic impurities as described previously
- The Contractor shall arrange to carry out the following tests when requested by the Engineer:
  - Specific gravity and water absorption.
  - Bulk density.
  - Other tests described in BS 812.

**Coarse Aggregates**

Coarse aggregates shall be clean, hard and durable crushed rock, crushed gravel or natural gravel complying with the requirements of BS EN 12620. The material shall be frost resistant and shall not contain any iron pyrites, iron oxides, flaky or laminated material, hollow shells, coals or other soft or
porous material, or organic matter. The pieces shall be predominantly angular, rounded or irregular as defined in BS 812.

Coarse aggregate shall be supplied in the nominal sizes called for in the Contract and shall be graded in accordance with BS EN 12620 for each nominal size.

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

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

- 40mm nominal size and above 2 per cent of dry weight
- 20mm nominal size 5 per cent of dry weight
- 10mm nominal size 15 per cent of dry weight

Chlorides soluble in a 10 percent 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 BS 812 but subject also to the further restriction on total chloride content given previously.

When tested in accordance with ASTM C289, the aggregate shall be non-reactive.

Soundness: After 5 cycles of the test set out in ASTM C88-76, the aggregate shall not show a weight loss of more than 12 per cent.

Flakiness Index: When tested in accordance with BS 812 shall be as set out hereunder:

- 40mm nominal size and above Not more than 40
- 20mm nominal size and below Not more than 34

If the flakiness index of the coarse aggregate varies more than five units from the average value of the aggregate used in the approved trial mix, a new set of trial mixes shall be carried out in the workability of the mixes have been adversely affected by such variation.

Impact Value: Not more than 45 per cent when tested in accordance with BS 812.

Ten per cent fines value: Not less than 50 kN when tested in accordance with BS 812.

Shrinkage: When mixed with other ingredients in the approved proportions for concrete and tested as set out in BS 1881, the shrinkage factor shall not exceed 0.05 per cent.

Water absorption: The aggregate shall not have water absorption of more than 2.5 per cent when tested as described in BS 812.

Tests on coarse aggregate shall be carried out daily or as required by the Engineer on site during concreting operations as follows:

- Sieve analysis
- Moisture content: An approved “rapid” test may be used for this test.
- Percentage of materials passing a 75 microns BS sieve by the Field Settling Test, checked when necessary by the Decantation Method.

The Contractor shall arrange to carry out the following tests when requested by the Engineer:

- Determination of Flakiness Index.
- Specific gravity and water absorption.
- Determination of “ten per cent fines” and of Los Angeles Abrasion.
- Other tests described in BS 812.

**Test for Organic Impurities**

Aggregates shall be tested for organic impurities by means of discoloration of a sodium hydroxide solution as follows:

A 340ml graduated prescribed bottle shall be filled to the 123ml mark with a sample of the aggregate to be tested. A 3 per cent solution of sodium hydroxide in water shall be added until the volume of the aggregate and liquid after shaking gives a total volume of 194ml. The bottle shall be stoppered, shaken thoroughly and allowed to stand for 24 hours. Should the liquid then be darker than the standard colour solution the aggregate shall not be used for making concrete.

The standard colour solution shall be prepared in a 340ml prescription bottle as follows:

- 2.5ml of a 2 per cent solution of tannic acid in 10 per cent alcohol shall be added to 97.5ml of a 3 per cent solution of sodium hydroxide in water. The mixture shall be shaken and allowed to stand for 24 hours.
- A glass of the standard colour may be used in place of the standard solution.

**Total Chloride and Sulphate Contents**

The total chloride content arising from all ingredients in a mix, expressed as chloride ions as a percentage of the weight of cement in a mix, shall not exceed 0.5 per cent in any one sample or 0.3 per cent in 95 per cent of the samples tested. For prestressed concrete, steam cured concrete or concrete containing sulphate resisting cement or super sulphated cement, the total chloride content shall not exceed 0.5 per cent of the weight of cement in the mix.

The total sulphate content arising from all ingredients in a mix shall not exceed 0.4 per cent by weight of the aggregates or 4 per cent of the weight of cement in the mix, whichever is less. For this purpose the sulphate contents shall be expressed as SO$_3$ and shall be calculated from the sulphate contents of the cement, aggregates and any admixtures. Where applicable, sulphate contents shall be determined in accordance with tests described in BS 1047 and 3892.

Pulverised fuel ash shall not be used in conjunction with a cement complying with the requirements of BS 4027 in concrete required to be resistant to sulphates.

**Admixtures**

Admixtures for improving workability, accelerating or retarding setting of concrete, or for any other purpose, shall comply with BS EN 934 and only be used with the Engineer’s written approval. Calcium chloride or admixture containing chlorides will, however, not be approved.

The Contractor shall submit samples of the admixtures he proposes to use to the Engineer for testing. If an admixture is approved for use it shall be obtained from an approved supplier and the Contractor’s arrangement for measuring, mixing and adding the admixture to the concrete batch shall be strictly in accordance with the manufacturer’s instructions or recommendations and subject to the approval of the Engineer.

The proportions of the concrete mixes and water/cement ratio shall be adjusted to the satisfaction of the Engineer so that the strength of the concrete with admixture is at least equal to the strength of the equivalent concrete without admixture.

**Water for Concrete**
Clean fresh water complying with BS EN 1008 is to be used for the mixing of all concrete and mortar, and is to be from a source approved by the Engineer.

**Concrete Mixes**

The design of concrete mixes shall be the sole responsibility of the Contractor, but may be undertaken in conjunction with the Engineer. Concrete mixes shall be designed mixes in accordance with the requirements of BS 5328 having the characteristics specified in Table 3.1 of this Specification. Concrete for use in water retaining structures shall comply with BS 8007.

Evidence shall be submitted to the Engineer, for all classes of concrete to be used, showing that at the intended workability the proposed mix proportions and production methods will produce concrete of the required quality.

The following information shall be provided before any designed mix is supplied:

- Nature and source of each material.
- Full details of tests on trial mixes including workability.
- Proposed quantities of each ingredient for one cubic metre of fully compacted concrete.

No change in the approved mix design will be permitted, unless the Contractor carries out trials on the proposed mix design to show that compliance with this Specification can be maintained.

Mix design shall in all cases be subject to the approval of the Engineer, but such approval shall in no way relieve the Contractor of his responsibility for the design and production of concrete in compliance with this Specification.

**Trial Mixes**

At least six (6) weeks before commencing the placing of any concrete in the works, trial mixes shall be prepared for each class of concrete to be used on the works. Three (3) batches of each class of concrete shall be made using materials typical of the proposed supply and under full scale production conditions. The workability of each of the trial batches shall be determined and three (3) cubes made from each batch for testing at 28 days. A further three (3) cubes made from each batch may be made for tests at an earlier age if required.

The trial mix proportions shall be approved if the average compressive strength of the nine (9) cubes tested at 28 days exceeds the specified characteristic strength by 3 Newtons per square millimetre, or if nine tests at an earlier age indicate that it is likely to be exceeded by this amount.

To demonstrate that the maximum free water/cement ratio is not exceeded, two batches of concrete shall be made in a laboratory with cement and surface-dry aggregate known from past records of the supplier of the material to be typical. The proposed mix proportions will not be accepted unless both batches have the cement content specified and free water/cement ratio below the maximum specified in table below.

### Classes of Concrete

<table>
<thead>
<tr>
<th>Class</th>
<th>Characteristic Compressive Strength N/mm²</th>
<th>Maximum Free Water/cement Ratio</th>
<th>Minimum Cement Content kg/m³</th>
<th>Maximum Cement Content kg/m³</th>
<th>Maximum Aggregate Size mm</th>
</tr>
</thead>
<tbody>
<tr>
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<td>25</td>
<td>0.55</td>
<td>360</td>
<td>400</td>
<td>10</td>
</tr>
<tr>
<td>C25/20/A</td>
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<td>0.55</td>
<td>360</td>
<td>400</td>
<td>20</td>
</tr>
<tr>
<td>C25/20/B</td>
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<td>20</td>
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<td>20</td>
</tr>
<tr>
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</tr>
<tr>
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<td>-</td>
<td>220</td>
<td>540</td>
<td>40</td>
</tr>
</tbody>
</table>
Testing of Concrete

General

All concrete shall be sampled and tested in accordance with the requirements of BS EN 12350 and BS EN 12390 unless otherwise stated in this Specification or instructed by the Engineer.

The Contractor shall allow for all the necessary labour, materials and equipment necessary for the regular sampling and testing of concrete to be placed in the Works.

Cement Content

Tests shall be carried out as required by the Engineer to determine the cement content of the mix. The cement content of any batch of concrete shall not be less than the specified minimum value minus 5 per cent of that value nor more than the specified maximum value plus 5 per cent of that value.

Workability

The workability of the concrete shall be measured as required by the Engineer by slump tests or compaction factor tests and shall be within the following limits:

- Slump: + 25mm or + one third of required value whichever is greater.
- Compacting Factor: + 0.03 where required value is 0.90 or more
- Factor: + 0.04 where required value is 0.90 to 0.80
- + 0.05 where required value is 0.80 or less

The required value shall be that which has been accepted under Clause 3.8 of this Specification.

Water/Cement Ratio

The water/cement ratio shall be determined as required by the Engineer and shall not exceed the specified maximum value by more than 5 per cent of that value.

Compressive Strength

Samples of concrete shall be taken for compressive strength at a rate of one sample per 15m$^3$ of concrete placed or 15 batches of concrete placed whichever is the lesser volume. A greater frequency of sampling may be instructed by the Engineer until compliance with specified strength requirements has been confirmed for each class of concrete used in the Works.

Two test specimens shall be prepared from each sample and shall be cured for 28 days, or by any other method approved by the Engineer that enables the prediction of 28 day strength at an earlier time.

On completion of curing, the two test specimens shall be tested. Provided the difference between the two results does not exceed 14 per cent of the mean of the two results, the mean shall be taken as the test result. Where the difference between the two results exceeds 14 per cent of their mean, the lower of the two results shall be taken as the test result.
Compliance with the specified strength may be assumed if the conditions given in both (a) and (b) below are satisfied.

The average compressive strength determined from any one group of four consecutive 28 day test results exceeds the specified characteristic strength by not less than $3 \text{N/mm}^2$ for classes of concrete C20, C25 and C30 and not less than $2 \text{N/mm}^2$ for class C15 concrete.

Each individual 28 day test result is greater than the specified characteristic strength minus $3 \text{N/mm}^2$ for classes of concrete C20, C25 and C30 or $2 \text{N/mm}^2$ for class C15 concrete.

If only one test result fails to meet the second requirement then that result may be considered to represent only the particular batch of concrete from which that sample was taken provided the average strength of the group satisfies the first requirement.

If more than one result in a group fails to meet the second requirement or if the average strength of any group of four consecutive test results fails to meet the first requirement, then all the concrete in all the batches represented by all such results shall be deemed not to comply with the strength requirements. For the purposes of this Clause, the batches of concrete represented by a group of four consecutive test results shall include the batches from which samples were taken to make the first and the last tests in the group of four, together with all the intervening batches.

**Failure to Comply with Specified Requirements**

Failure of concrete to comply with the specified requirements will result in it being classified as defective work. Immediately on notification by the Engineer that concrete work is defective, the Contractor shall take all measures necessary to improve concrete quality before further concrete is placed in the Works. If required by the Engineer, the rate of sampling of concrete shall be increased until adequate control is again established. Tests shall be carried out on the defective concrete or test cores taken from it to establish its in-situ strength. If the results of these tests satisfy the Engineer that the defective concrete will fulfil its design function then it may be accepted. If not, the Contractor shall propose strengthening or remedial work where possible or shall remove the defective concrete from the Works.

**Concrete Returns and Records**

The Contractor shall send weekly to the Engineer a return showing the quantities of cement and the number of mixings of each class of concrete used in each section of the Works.

Records shall be kept by the Contractor of the positions in the Works of all batches of concrete, of their class and of all test cubes or other specimens taken from them. Copies of these records shall be supplied to the Engineer.

**Equipment and Construction Procedure**

The design, layout, installation and operation of equipment for processing, handling, transporting, storing and proportioning concrete ingredients and for mixing, transporting and placing concrete shall be to the satisfaction of the Engineer. Before the equipment is ordered or delivered to site, the Contractor shall submit to the Engineer drawings showing the proposed arrangements of the equipment together with detailed descriptions of the equipment proposed.

**Batching**

The aggregates and cement shall be proportioned by means of efficient weigh batching machines except when the Engineer has approved the use of volume batching. The machines shall be carefully maintained and cleaned and they shall be provided with simple and convenient means of checking the accuracy of the weighing mechanism, and they shall be checked when required by the Engineer.

For volume batching suitable gauge boxes shall be used.
Mixing Concrete by Machine

Where the concrete is to be mixed in machines, these shall be of the batch mixing or other approved type. The machines shall ensure that all the concreting materials including the water are thoroughly mixed together before any portion of the mixture is discharged. The mixing time shall not be less than thirty seconds per cubic foot (30sec/cft) of concrete, with a minimum of three minutes (3min) mixing time per batch. The machines must be capable of discharging their contents while running.

Mixing Concrete by Hand

Where it is not possible to employ machine mixing and approval has been obtained from the Engineer, concrete shall be mixed by hand as near as practicable to the site where it is to be deposited. Clean mixing bankers or platforms of sufficient area for the proper execution of the work shall be provided. These platforms if constructed of timber shall consist of planks closely jointed so as to avoid the loss of any grout or liquid from the wet concrete. The whole of the aggregate and cement shall be turned over on the banker in a dry state at least twice. The water shall then be added gradually through a rose head, after which the materials shall again be entirely turned over in a wet state at least three times.

Preparation of Surface to Receive Concrete

Foundations which are to receive concrete shall be properly drained and dewatered so that no water runs over or stands on a surface on which concrete is being placed. If required by the Engineer drains provided through or beneath concrete for the temporary conveyance of water shall afterwards be completely sealed to the Engineer’s approval.

Before deposition of concrete against rock, the rock surface shall be thoroughly wetted and cleaned by the application of water, or of water and air, under pressure. No concrete shall be deposited until the surface has been cleaned and passed as satisfactory by the Engineer.

Faults or seams in the rock shall be cleaned to a depth satisfactory to the Engineer and if necessary stemmed with cement mortar of an approved mix.

Before any steel reinforcement is embedded in the concrete any loose mill scale, loose rust and any oil, grease or other deleterious matter shall be removed. Partially set concrete which may adhere to the exposed bars during concreting operations shall likewise be removed.

Authority to Commence Placing of Concrete

The Contractor shall give the Engineer at least 24 hours’ notice of his intention to place concrete in a particular section of the Works. Before concrete is placed the Contractor shall apply to the Engineer for approval of the cleanliness, alignment and suitability of surfaces against which the new concrete is to be placed and of the fixing of formwork, reinforcement, embedded parts and the like and he shall obtain written permission from the Engineer to proceed with concreting.

The Contractor shall carefully plan his concreting operation to ensure, where possible, that these operations are completed within the normal working day.

Dimension of Concrete Pours and Programme of Placing

Unless otherwise approved by the Engineer concrete shall be cast in one operation between external faces of concrete and joints shown on the Drawings or between construction joints or both.

The Contractor shall submit and obtain the Engineer’s approval to a detailed concreting programme and his proposals for the location of construction joints.

Transport and Deposition of Concrete
Concrete shall be transported and deposited in such manner as to prevent segregation, loss of materials or contamination with foreign matter. The means of transport of concrete shall be subject to the approval of the Engineer. The containers for conveying the concrete shall be thoroughly cleaned immediately after use and sides dampened before work is started or restarted to prevent cement and fine material in the first batch adhering to the sides. Adequate precautions shall be taken to protect the concrete against wetting or drying out through exposure to the weather and to prevent segregation and consolidation of the mix due to prolonged jolting of the concrete. Concrete shall be placed in its final position and fully compacted before the onset of initial set. Wherever possible, concrete shall be deposited vertically in the final position required and shall not be dropped through a greater height than 1.5m. Where necessary, bins, drop chutes, downpipes or baffles shall be provided to prevent segregation of the material. Drying out of fresh concrete before deposition shall be prevented by the provision where necessary of suitable covers. Loss of slump during transport and deposition of the concrete shall not exceed 25mm.

Concrete shall not be placed in standing or running water unless so specified. Where concrete has to be placed under water, the Contractor shall submit to the Engineer his proposals indicating the methods and equipment to be employed. The concrete shall be deposited by bottom discharging watertight containers or through funnel shaped tremies which are kept continuously full with concrete up to a level above the water and which shall have the discharging bottoms 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 and additional cement of about 25% must be added.

**Distribution and Spreading of Concrete**

Concrete shall be placed in layers not exceeding 500mm in depth approximately parallel to the horizontal or inclined construction joint planes. These layers shall be deposited from one face to the other until the full height of the lift is reached. Each layer shall be deposited on the previous one before the latter has taken its initial set and the exposed area of fresh concrete shall be maintained to the practical minimum. In order to accomplish this timing a new layer may be started before the previous layer is completed.

The face from which placing of concrete is to commence shall be selected so that if an emergency should occur which prevents the layer being completed the vertical construction joint will be formed in a structurally acceptable position.

Concrete shall not be placed during rain sufficiently heavy or prolonged to wash mortar form coarse aggregate on the exposed sloping faces of fresh concrete unless adequate shelter is provided.

Concrete shall not be placed against any surface (including formwork, reinforcement, embedded steelwork, adjacent concrete or rock) which during hot weather is not adequately dampened to prevent excessive absorption of water from the fresh concrete.

Once commenced, concreting shall be carried on as continuous operation between pre-arranged constructions, expansion or contraction joints save only if an emergency occurs and interruption is unavoidable. The Contractor shall have readily available suitable prefabricated formwork for stop ends to form emergency vertical construction joints and, in the event of such an interruption occurring, the concrete already placed shall be properly finished up to the stop end and to a horizontal or inclined surface as directed by the Engineer. In water retaining structures the Contractor shall propose methods of making the joint watertight.

Concrete shall be placed carefully so as not to displace the formwork or reinforcement.

**Compaction of Concrete**

The Contractor shall thoroughly compact all concrete immediately after it has been placed in position. Unless otherwise authorised by the Engineer, compaction shall be accomplished with the aid of immersion vibrators as specified below, together, if necessary, with rods, shovels and the like. Particular care shall be taken to fill all voids and to work the concrete against rock and existing
concrete surfaces, round any reinforcement and embedded fixtures and into the corners of the
tformwork.

If the Contractor does not wish to use immersion vibrators for any portion of the works he shall
submit his proposals for alternative vibrators or compaction equipment and shall receive the
Engineer's approval to the equipment before commencing to concrete the portion concerned.

Vibrators shall be of a type and size adequate for the portion placed. Vibrators shall operate at a
frequency of between 7000 and 10000 impulses per minute. The Contractor shall ensure that
vibrators are operated at pressures and voltages not less than those recommended by the
manufacturer in order to ensure 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 stand-by vibrators shall be available
for instant use at each concreting place. The length and diameter of the vibrating element of
immersion vibrators shall be sufficient to penetrate through the layer of concrete being placed and
re-vibrate the upper portion of the underlying layer of concrete. Only men experienced in the use
of vibrators shall be employed on this type of work.

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. The period of vibration
necessary shall be determined by trial in the presence of the Engineer. Vibration shall then be
continued for this period at each point before any further concrete is superimposed.

Immersion vibrators shall be inserted vertically to penetrate into the layer underneath at regular
intervals, which shall not exceed the distance from the element over which vibration is visibly
effective and in any case shall not exceed 700mm. Vibrators shall not be used to move concrete
laterally and shall be withdrawn slowly to prevent the formation of voids. Vibrators shall not be
applied to reinforcement or other embedded items.

Protection of 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 this cause.

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 Permanent Works shall not be subjected to any structural loading until it
has attained at least its nominal strength.

If the Contractor desires to impose structural 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.

No Partially Set Concrete shall be used

All concrete must be placed and compacted in its final position within thirty minutes (30min) of
discharge from the mixer unless otherwise approved. No partially set material shall be used in this
work.

Plum Concrete

Plums shall be hard clean natural stones embedded in mass concrete during the placing of the
concrete. Unless otherwise shown on the drawings, the plums shall not be larger than one third of
the cross section of the concrete and should not be placed closer than 150mm to each other
vertically and 100mm horizontally. The volume of plums shall unless otherwise specified, not
exceed forty per cent (40%) of the mass concrete volume and care shall be taken to ensure that
the minimum cover over any plums is 100 mm.
Concreting in Adverse Weather

No concreting will be allowed to take place in the open during storms or heavy rains. Where strong winds are likely to be experienced additional precautions to ensure protection from driving rain and dust shall also be taken.

The Engineer may withhold approval of commencement of concreting until he is satisfied that full and adequate arrangements have been made.

Concreting at Night or in the Dark

Where approval has been given to carry out concreting operations at night or in places where daylight is excluded, the Contractor is to provide adequate lighting at all points where mixing, transportation and placing of concrete are in progress.

Concreting in High or Low Ambient Temperature

Where the ambient temperature exceeds thirty two degrees Celsius (32°C), the Contractor shall take special measures in the mixing, placing and curing of concrete. The temperature of the concrete when deposited shall not exceed thirty degrees Celsius (30°C). The Contractor shall carry out all necessary special measures to ensure that the maximum concrete temperature after placing shall not exceed fifty degrees Celsius (50°C) or thirty degrees Celsius (30°C) above the concrete temperature at the time of placing, whichever is lower.

During placing suitable means shall be provided to prevent premature stiffening of the concrete placed in contact with hot surfaces.

The Contractor shall not mix and place concrete when the ambient temperature falls below three degrees Celsius (3°C).

Curing and Protection

Concrete shall be protected during the first stage of hardening from the harmful effects of sunshine, drying winds, cold, rain or running water. The Contractor shall pay particular attention to the need to protect concrete immediately after the finishing operation and prior to its final set and shall submit their proposals to achieve this protection for the Engineer’s approval. Protection of concrete which has achieved its final set shall consist of one or more of the following:

a. A layer of sacking, canvas, hessian, straw mats or similar absorbent material or a layer of sand, kept constantly moist by spraying with water as necessary for fourteen (14) days or such periods as may be directed by the Engineer.

b. After thoroughly wetting, a layer of approved waterproof paper or plastic membrane kept in contact with the concrete for fourteen (14) days or such period as may be directed by the Engineer.

The use of saline water for curing purposes will not be permitted.
6.1.14. STEEL REINFORCEMENT

Materials

Unless otherwise directed or otherwise shown on the Drawings, hot rolled high yield reinforcement shall be used throughout the works.

Where required, mild steel reinforcement, medium tensile steel reinforcement and high tensile steel reinforcement shall comply with BS 4449. Cold twisted steel wire for the reinforcement of concrete shall comply with BS 4482.

All reinforcement shall be from an approved manufacturer and, if required by the Engineer, the Contractor shall submit a test certificate of the rollings. The Contractor shall, when requested by the Engineer, provide sample pieces 1.0m long for testing.

Tying wire shall be 1.6mm diameter soft annealed iron wire.

Before any steel reinforcement is embedded in the concrete any loose mill scale, loose rust and any oil, grease or other deleterious matter shall be removed. Partially set concrete which may adhere to the exposed bars during concreting operations shall likewise be removed.

Fabricating Reinforcement

Bar reinforcements shall be bent to the shapes shown on the Drawings and bending schedules. All bars shall be bent cold, unless otherwise permitted by the Engineer. All hooks, bends, and the like, unless otherwise shown on the Drawings, shall be to BS 4666. The Contractor shall satisfy himself as to the accuracy of any bar bending schedules supplied and shall provide all reinforcement in accordance with the Drawing. Bar reinforcement shall be bundled and each bundle of steel shall be tagged with identifying tags, showing the size and mark of the bar. The bundles shall be stacked clear of the ground in easily accessible positions that do not in any way hinder the progress of work and shall be kept clean.

Fixing Reinforcement

When placed in the work reinforcement shall be free from coatings or dirt, detrimental scale, paint, oil or other foreign substances. When steel has on its surface rust, loose scale and dust which is easily removable, it may be cleaned by a method approved by the Engineer.

All reinforcing bars, ties, links and fabric shall be fixed in the positions shown on the Drawings within the tolerances specified in BS 8666. In no case shall the cover specified on the Drawings be increased by more than 5mm.

Displacement of reinforcement beyond the specified tolerance shall be prevented by supporting the bars sufficiently and securely fixing them together at intersections where necessary.

The ends of all tying wires shall be turned into the body of the concrete and not allowed to project towards the surfaces of the concrete.

Spacers shall be used to maintain the cover to all steel and shall be made of dense cement mortar of one part cement and two parts sand.

Spacers shall be triangular in section and only one acute edge shall bear against the formwork, the flat side shall bear against the steel. Wire cast into the blocks to fix them to the reinforcement shall be 1.6mm diameter soft annealed iron. Spacers shall not be used on the wet face of water retaining or water excluding structures. Chairs, stools, etc. shall be used to maintain clearance between two or more layers of reinforcement.

Nothing shall be allowed to interfere with the specified position of reinforcement. The fixing of reinforcement shall be checked before and during concreting, and particular attention shall be given
to the position of top steel in cantilever sections. During concrete placing a competent steel fixer shall be in attendance to adjust and correct the position of any reinforcement which may be displaced.

**Splicing and Lapping**

All reinforcement shall be provided in full lengths as indicated on the Drawings or bending schedules. Splicing of bars, except where shown on the Drawings, shall not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible. Bar reinforcement shall not be welded without the Engineer’s written permission.

In lapped splices, the bars shall be placed in contact and wired together in such manner as to maintain a clearance between bars of not less than 50mm.

Mesh or bar reinforcement shall overlap sufficiently to maintain a uniform strength and shall be securely fastened at ends and edges. The edge lap shall not be less than 40 diameters of the mesh reinforcement bar or two mesh widths whichever is greater.

**Cover to Reinforcement**

The concrete cover to reinforcement shall be 50mm unless otherwise shown on the Drawings.

The Contractor shall provide any necessary concrete pads for ensuring the cover is attained and in no case shall timber packing be used.
**6.1.15. FORMWORK**

**Definitions**

Forms, formwork or shuttering shall mean all temporary moulds forming the concrete to the required shape together with any special lining that may be required to produce the concrete finish specified.

Falsework or centering shall mean the furnishing, placing and removal of all temporary construction such as framing, props and struts required for the support of forms.

**Materials**

The formwork may be of seasoned, planed, tongued and grooved timber, plywood, blockboard, tempered hardboard, steel or as specified on the Drawings.

All timber used for formwork shall be sound wood, well seasoned and free from loose knots, shakes, large checks, warping and other defects. Before use on the work, it shall be properly stacked and protected from injury from any source. Any timber which becomes badly warped or cracked, prior to the placing of concrete shall be rejected. All formwork for outside surfaces before final ground level shall be either tongued and grooved or provided with a suitable lining to produce a smooth surface finish.

**Forms**

All forms shall be of wood or metal and shall be built grout-tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incidental to the construction operations. Forms shall be constructed and maintained so as to prevent warping and the openings of joints due to shrinkage of the timber.

The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration of concrete as it is placed.

All formwork shall, unless otherwise directed, be provided with 25mm by 25mm angle fillets (chamfers) so as to form splays on internal and external angles.

A grout check formed from 25mm square hardwood timber shall be incorporated in the formwork to provide a clean, level, horizontal joint on exposed concrete surfaces at the top of each lift.

All joints in the formwork shall be either horizontal or vertical. End formwork shall be square across the mass of concrete.

Where concrete is to be deposited to a slope steeper than 20 degrees to the horizontal, top formwork shall be used to enable the concrete to be properly compacted unless the Engineer agrees otherwise.

Openings for the inspection and cleaning of the inside of formwork for walls, piers and columns shall be formed in such a way that they can be closed conveniently before commencing to place concrete.

Form clamps, tie bolts and anchors shall be used to fasten forms. The use of wire ties to hold forms in position during placing of concrete will not be permitted. Tie bolts and clamps shall be positive in action and of sufficient strength and number to prevent spreading or springing of the forms. They shall be of such type that no metal part shall be left within the specified concrete cover. For water retaining sections, methods of fixing the forms which result in holes through the concrete section when the formwork is removed shall not be used and built-in wall ties shall be fitted with water baffles.

All forms for outside surfaces shall be constructed with stiff wales at right angles to the studs and all form clamps shall extend through and fasten such wales.
The shape, strength, rigidity, grout tightness and surface smoothness of forms which are re-used shall be maintained at all times. Any warped, bulged or otherwise damaged timber shall be replaced. Forms which are unsatisfactory shall not be re-used. If the surface finish on the formed concrete deteriorates as a result of deterioration of the faces of the forms, the Engineer shall instruct that forms be resurfaced, or discarded.

All forms shall be treated with approved mould or similar oil or be soaked with water immediately before placing concrete to prevent adherence of concrete. Any materials which adhere to or discolour concrete shall not be used.

All forms shall be set and maintained true to the line designated until the concrete is sufficiently hardened. Forms shall remain in place for periods which shall be as specified in Clause 3.26. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer shall order the work stopped until the defects have been corrected.

All formwork shall be approved by the Engineer before concrete is placed within it. The Contractor shall, if required by the Engineer, provide copies of calculations of the strength and stability of the formwork and falsework. Notwithstanding the Engineer’s approval of these calculations, the Contractor shall be held responsible for the safety and adequacy of formwork.

**Falsework and Centering**

Detailed plans for a falsework or centering shall be supplied by the Contractor to the Engineer at least 4 days in advance of the time the Contractor begins construction of the falsework. Notwithstanding the approval of the Engineer of any designs for falsework submitted by the Contractor, the Contractor shall be solely responsible for the strength, safety and adequacy of the falsework or centering.

All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads from the weight of green concrete and shuttering and incidental construction loads.

Falsework or centering shall be founded upon a solid footing safe against undermining and protected from softening. Falsework which cannot be founded on satisfactory footings shall be supported on piling which shall be spaced, driven and removed in a manner approved by the Engineer. The Engineer may require the Contractor to employ screw jacks, or hard wood wedges to take up any settlement in the formwork either before or during the placing of concrete.

Falsework shall be set to give the finished structure the required grade and camber shown on the Drawings.
Forms for Joints

Where permanent or temporary joints are to be made in horizontal or inclined members, stout stopping off boards shall be securely fixed across the mould to form a water-tight joint. The form of the permanent joint shall be as shown on the Drawings.

Where reinforcement or water stops pass through the face of a joint the stopping off board shall be drilled so that the bars or water stop can pass through, or the board shall be made in sections with a half round indentation in the joint faces for each bar so that when placed the board is neat and accurate fit and no grout leaks from the concrete through the bar holes, joints or around the water stop.

Release Agents

Only approved chemical release agents, mould creams (emulsions of water in oil) or oils containing a proportion of surfactant not exceeding 2 percent will be permitted. Water soluble emulsions and oils without surfactant shall not be used. Oil based release agents shall be applied at a rate of 7 square metres per litre one day in advance of concreting, preferably by spray or roller. Chemical release agents shall be applied in accordance with the manufacturer’s recommendations.

New timber face work shall be given three coats of release agent before use on the work to ensure uniformity of porosity on the surface.

On no account shall the release agent come into contact with the reinforcement.

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 the following Table and apply to ambient temperatures higher than 10°C. At lower temperatures or if cements other than ordinary Portland are involved, the Engineer may instruct longer periods.

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

<table>
<thead>
<tr>
<th>Position of formwork</th>
<th>Striking Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam sides, walls and columns</td>
<td>1 to 2 days</td>
</tr>
<tr>
<td>Slab soffits - props remain undisturbed</td>
<td>4 days</td>
</tr>
<tr>
<td>Beam soffits - props remain undisturbed</td>
<td>7 days</td>
</tr>
<tr>
<td>Removal of slab props</td>
<td>14 days</td>
</tr>
<tr>
<td>Removal of beam props</td>
<td>21 days</td>
</tr>
</tbody>
</table>
Surface Finishes

General

After removal of the formwork no treatment of any kind other than that required for curing the concrete shall be applied to the concrete faces until after inspection by the Engineer. All honeycombed areas, deformed surfaces or other defective surfaces shall then be repaired at the direction of the Engineer. Immediately following the Engineer’s inspection of surface finish, all tie bolt cavities shall be filled with sand cement mortar and the surface left smooth, sound, even and uniform in colour.

Should the finishes surface either as-stuck or after repair exhibit a non uniform colour or texture, the Engineer shall have the right to order that the surface be given a skim coat and then painted.

Formed Surfaces

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.

For warped surfaces, facings shall be built up of laminated splines cut to make a tight surface which shall then be dressed and sanded to the required curvature.

**Type F1:** This finish is for surfaces against which backfill or further concrete will be placed. Formwork shall consist of sawn boards, sheet metal or any other suitable material which will prevent the loss of grout when the concrete is being placed.

**Type F2:** 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 Type F2 finish shall be faced with wrought thicknesses tongued and grooved boards with square edges arranged in a uniform pattern and close jointed or with suitable sheet material. The thickness of boards or sheets shall be such that there shall be no visible deflection under the pressure exerted by the concrete placed against them. Joints between boards or panels shall be horizontal and vertical unless otherwise directed. This finish shall be such as to require no general filling of surface pitting, but fins, surface discoloration and other minor defects shall be remedied by methods agreed by the Engineer.

**Type F3:** This finish is for surfaces which will be in contact with water flowing at high velocity and for surfaces permanently exposed to view where good appearance and alignment are of importance. To achieve this finish, which shall be free of boardmarks, the formwork shall be faced with plywood complying with BS 1088 or equivalent material in large sheets. The sheets shall be arranged in an approved, uniform pattern. Wherever possible, joints between sheets shall be arranged to coincide with architectural features or changes in direction of the surface. Suitable joints shall be provided between sheets to maintain accurate alignment in the place of the sheets. Unfaced wrought boarding or standard steel panels will not be permitted for Type F3 finish. The Contractor shall ensure that the surface is protected from rust marks, spillages and stains of all kinds.
Type F4: This finish is similar to that required for type F3 but is used in places where a first class alignment and a dense surface free from airholes and other defects is required, suitable for the application of decorative finishes, in very high velocity water channels and in other similar circumstances.

Unformed Surfaces

Type U1: This is screed finish for surfaces of roads of foundations, beds, slabs, and structural members to be covered by backfill, subsequent stages of construction, bonded concrete topping or cement mortar beds to receive pavings, and on exposed surfaces of paving where a superior finish is not required. It is also the first stage of Type U2 and U3 finishes. The finishing operations shall consist of levelling and screeding the concrete to produce a uniform, plane or ridged surface, surplus concrete being struck off by a straight edge immediately after compaction.

Type U2: This is a floated finish for exposed surfaces where a hard smooth steel trowelled surface is not required. Floating shall be done only after the concrete has hardened sufficiently, and may be by hand or machine. Care should be taken that the concrete is worked no more than is necessary to produce a uniform surface free from float marks.

Type U3: This is a hard smooth steel trowelled finish for surfaces exposed to water flowing at high velocity. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked to the surface. The surface shall be trowelled under firm pressure and left free from trowel marks.

Type U4: This finish is similar to Type U3 finish but the permissible tolerances are smaller.

Surface Tolerances

All parts of concrete surfaces shall be in the positions shown on the Drawings within the tolerances set out in the document.

In cases where the Drawings call for tolerances other than those given in table or the Drawings shall rule.

Where precast units have been set to a specified tolerance, further adjustments shall be made as necessary to provide 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.

Surface Tolerance for Formed Surfaces

<table>
<thead>
<tr>
<th>Type of Finish</th>
<th>Tolerance in mm (See Note 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>F1</td>
<td>10</td>
</tr>
<tr>
<td>F2</td>
<td>5</td>
</tr>
<tr>
<td>F3</td>
<td>2</td>
</tr>
<tr>
<td>F4</td>
<td>See Note 2</td>
</tr>
</tbody>
</table>

Note 1: The tolerances specified above are the maximum deviations from the desired position.

Note 2: The tolerances for Type F4 shall be as specified in Note 1.
Note 1:
The tolerances, A, B and C given in the table are defined as follows:

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

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

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

Note 2:
Abrupt irregularities are not permitted in a Type F4 finish. Any residual irregularities which remain after removal of formwork shall be removed by grinding to achieve a transition of 1 in 50 between the surfaces adjacent to the irregularity.

<table>
<thead>
<tr>
<th>Type of Finish</th>
<th>Tolerance in mm (See Note 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D</td>
</tr>
<tr>
<td>U1</td>
<td>-</td>
</tr>
<tr>
<td>U2</td>
<td>Nil</td>
</tr>
<tr>
<td>U3</td>
<td>Nil</td>
</tr>
<tr>
<td>U4</td>
<td>Nil</td>
</tr>
</tbody>
</table>

Notes:

**D** is the maximum allowable value of any sudden change of level in the surface.

**E** is the maximum allowable value of any gradual irregularity of the surface, as indicated by the gap between the surface and a 3m long straight edge or correctly shaped template placed on the surface.

**F** is the maximum allowable value of the difference in level or position between a straight edge or correctly shaped template placed on the surface and the specified level or position of that surface.

Conduits, Box-outs and Apertures
The layout of conduits, box-outs, grooves, apertures and the like shall be as shown on the Drawings or as directed by the Engineer, and shall be subject to inspection and approval by the Engineer before commencing concreting.

Conduits shall be placed as near the centres of members as possible and sufficient space shall be provided between adjacent conduits to prevent difficulties in the placing of concrete.

Box-outs, holes, grooves, apertures and the like shall be accurately set out in the formwork prior to placing the concrete. Fixing blocks, ends of brackets, bolts and, where possible, built in parts shall be cast into the concrete at the time of placing. No part of the concrete works shall be cut out for any such item, or for any other reason, without the Engineer’s permission.
The Contractor shall ensure that all sub-contractors are informed of his programme for the structural works at the commencement of the Contract and that such sub-contractor’s requirements relating to concrete members are approved well in advance. The Contractor shall obtain from all such sub-contractors complete information of their requirements regarding conduits, pipes, fixing blocks, ducts, holes and any other items to be cast into or formed in the concrete members. Failure of a sub-contractor to sub-contractor to supply such information shall not be allowed to delay the progress of the Works.

**Construction joints**

Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be as indicated on the Drawings or as previously approved by the Engineer. The Contractor is to allow for working beyond the ordinary working hours where necessary in order that each section of concrete may be completed without any lapse while the work is in hand. All construction joints are to be formed square to the work.

Where vertical construction joints are required, the joint face of the first stage concrete shall be finished against a stopping-off board, or vertical end shutter, suitably notched to pass the reinforcement. When the concrete is hard and the shutter is removed, the whole joint surface shall be thoroughly hacked and roughened or scabbled with suitable tools so that no smooth skin of concrete is visible and that all aggregates and solid matrix around them is exposed.

For horizontal or slightly inclined construction joints, the surfaces shall preferably be prepared when the concrete has set but not hardened by jetting with a fine spray of water and brushing with a stiff brush to remove the smooth skin and expose the aggregate without disturbing it. Where this treatment is impractical and work is resumed after the concrete surface has hardened, a similar procedure shall be adopted as on vertical joints.

If, in the opinion of the Engineer, any deleterious material has come into contact with the concrete of the construction joint or if the concrete is honeycombed or unsound for any reason, the concrete shall be cut back to such a depth as the Engineer shall order and the roughened surfaces shall be thoroughly cleaned by compressed air and water jets or other approved means.

Immediately before concreting is resumed, the roughened joint surface shall be thoroughly cleaned with compressed air and water jets and slightly wetted and cement grout placed. The Contractor shall take precaution to avoid segregation of the concrete along the joint plane and to obtain thorough compaction.

**Movement joints**

Movement joints shall be formed in the position and manner shown on the Contract Drawings or instructed by the Engineer. In the case of water retaining structures, joints shall be made watertight by the provision of a continuous waterstop, with suitable water resistant filler material and sealant. The materials and workmanship utilised in movement joints shall comply with the following:

a. Compressible filler shall be self-expanding cork filler consisting of cork granules bonded together with an insoluble, synthetic resin. When subject to wet or moist conditions the filler shall be capable of swelling to occupy a larger volume than that of the material supplied. The expansion properties of the filler shall not be less than one hundred and forty per cent (140%) when immersed in boiling water for one hour (1hr). The filler shall be supplied and stored in sealed moisture resistant wrappings. Compressible filler shall be secured to the first cast concrete surface using an approved adhesive.

b. Waterstops, either centrally or externally placed, shall be Polyvinyl Chloride (PVC) of the dimensions and type shown on the Drawings. PVC waterstops shall have an elongation of at least 300% at rupture with a tensile strength of more than 12.3N/mm². Glueing temperature shall be about 150°C. The PVC waterstop shall accommodate a transverse
movement of at least 50mm. For expansion joints the waterstops shall incorporate a centre bulb or box to allow movement to be accommodated. Centrally placed waterstops shall have reinforced eyelets on the outer flange to facilitate the positioning of the water stops by wiring to the surrounding steelwork. Externally placed waterstops shall include a wide reinforced nailing flange for positive fixing to formwork or adjacent concrete faces. Waterstop shall be firmly supported by split stop-end shuttering where appropriate, and in no case shall the waterstops be pierced to assist in fixing. Special care should be taken to ensure that the concrete is well worked against the embedded part of the waterstops and is free from honeycombing. Precautions shall be taken to protect any projecting portions of the waterstops from damage during the progress of the work and from sunlight and heat. Where waterstops are required to be jointed, this shall be undertaken using approved heat welding equipment. The waterstops shall be installed in accordance with the manufacturer's instructions and to the approval of the Engineer.

c. Joint sealant shall be bitumen-rubber sealing compounds and shall be pourable and in accordance with BS 2499 for horizontal joints and shall be an approved solvent type gun grade applied by suitable for vertical joints.

d. Miscellaneous materials necessary for the installation of movement joints such as adhesives for securing filler materials, bond breaking tapes, bituminous paints for creating a discontinuity between concrete surfaces and primers shall be compatible with the compressible filler, waterstops and sealant specified previously.

Contraction joints where specified shall be formed in the position and manner shown on the Drawings. The reinforcement shall be discontinuous across the joint. Dowel bars, waterstops and sealant shall be provided as shown. The face of the first stage concrete shall be finished fair faced and after curing painted with two coats of bituminous paint. Casting of waterstops and sealing of joints is to be carried out in accordance with the manufacturer’s instructions. Dowel bars shall be round mild steel of the dimensions shown on the Drawings. The bars shall be cast into the first stage concrete and the protruding part shall be painted with two coats of bituminous paint.

Expansion joints where specified shall be formed in the position and manner shown on the Drawings. The reinforcement shall be discontinuous across the joint. Dowel bars, waterstops, compressible filler and sealant shall be provided as shown. The face of the first stage concrete shall be finished fair faced and after curing the compressible filler shall be fixed in position in a manner to the approval of the Engineer. Casting in of waterstops and sealing of joints is to be carried out in accordance with the manufacturer’s instructions. Dowel bars shall be round mild steel of the dimensions shown on the drawings. The bars shall be cast into the first stage concrete and the protruding part shall be painted with two coats of bituminous paint. An end cap shall be fixed to the end of each bar prior to pouring the second stage concrete, in order to create a void at the end of the bar to accommodate any movement.

Precast Concrete Units

Precast concrete units shall be provided by an approved specialist supplier or may, subject to the Engineer’s written approval, be manufactured by the Contractor. The Engineer may require the Contractor to supply samples of precast concrete units for testing prior to the approval of the proposed supply for each type of unit and such samples shall be supplied and tested as directed by the Engineer.

Precast concrete units shall be made in accordance with the provisions of this Specification covering concrete work. Precast concrete units shall be manufactured under shed roofs and protected from the weather. The units shall remain in the moulds for seven days and shall remain protected for a further seven days, during which periods the concrete shall be shielded by sacking or other approved material which shall be kept wet. The units shall then be moved from the sheds and stacked in the open for at least a further seven days to season before being set in position.
Precast concrete work shall be tested as directed by the Engineer and work failing to meet the requirements of the Specification shall be rejected. Precast units that become damaged during handling shall likewise be rejected.

The Contractor shall, when required, make arrangements with his supplier for access to the supplier’s work for the Engineer to inspect and carry out tests on precast concrete units.

All precast units shall be marked with individual identification. Lifting hooks are to be attached only to those positions shown on the Drawings or detailed by the Engineer. The Contractor shall be deemed to have included in their rates for all measures required to handle and stack units safely and without undue stressing.

**Breaking out Existing Concrete or Block work**

Well in advance of the commencement of the work the Contractor shall seek the approval of the Engineer regarding the proposed method of breaking out existing concrete or blockwork in the positions shown on the Drawings or as directed by the Engineer.

**Cement Grout**

Cement grout for general purposes shall consist of Portland cement and water mixed in the proportion of one (1) part by volume of cement and one and a half (1.5) parts by volume of water. The grout shall be used within one hour (1hr) of mixing.

**Cement Mortar**

Cement mortar shall be machine mixed and unless otherwise specified, consist of three (3) parts of sand to one (1) part of Ordinary Portland cement mixed and thoroughly incorporated together. Just enough water will be added to give a workability appropriate to its use. The above proportions are by volume. Mortar shall be used whilst freshly mixed and no softening or retempering will be allowed.

**Concrete Block and Bricks Masonry**

Concrete blocks and bricks shall comply with BS 6073: Part 1 and shall have a minimum 28 days compressive strength of 3.5N/mm$^2$ and 7N/mm$^2$ respectively. The concrete blocks and bricks shall be laid in a staggered pattern such that the vertical joints between two consecutive layers are offset by half a block length. Joints on the inside faces shall be rendered in which case the joints shall be raked out at a depth of 5mm. Rendering shall consist of 1:2 mortar applied to a thickness so as to ensure professional finish.

The mix used to manufacture concrete blocks shall not be leaner than 1:9 by volume and the maximum size of aggregate shall be 10mm. The standard size of the concrete block shall be 400mm x 200x 200mm and 300 x 100 x 100mm for bricks. However blocks and bricks of other sizes may be used if approved by the Engineer for proper bonding at corners and openings.

The concrete blocks and bricks shall be wetted before laying and shall be set in mortar, which complies with the specifications given in previous sections. Unless otherwise stated, the maximum joint thickness shall be 12mm and the horizontal and vertical joints shall be filled with mortar. Joints shall be finished flush with the face of the blocks and bricks. The Concrete block and brick masonry shall be cured for a period of seven days by covering the work with two layers of hessian, which is kept permanently saturated. Provision shall be made to clean all exposed faces both as the work proceeds and on completion so that they are left in a neat, tidy and clean condition.

Building masonry will not be permitted in heavy rain without the approval of the Engineer. In such instances the Contractor shall make provision to protect materials and the newly placed mortar from the rain.

Concrete blocks shall either be obtained from an approved manufacture or made on site in approved block making machines. When casting of the concrete blocks is done at site, these shall
be removed from the casting machine and deposited on edge on covered racks and left for 3 days, during which time they shall be kept constantly wet. Afterwards they may be placed on racks in the open provided they are protected by hessian cloth or similar and kept wet for a further 5 days. Thereafter they shall not be moved or used in the works until they are 28 days old.

Chambers shall be constructed after pipes have been laid, except the bases may be constructed earlier to avoid deterioration of the formation.

Backfilling around completed chambers shall be with suitable material deposited equally all round and compacted in accordance with the Specifications.

Where any pipes are built into concrete or block work the pipe shall be surrounded in two layers of polythene sheeting unless a puddle flange has been shown on the Drawings.

**Rendering Work**

**Material**

Cement, water and fine aggregate shall conform to the requirements specified in the concrete works. Mesh reinforcement shall be plain diamond expanded steel lathing to BS 1369 where specified. Lime shall be to BS 980 and shall be mixed with water and allowed to stand prior to use according to the manufacturer’s recommendations.

The mix proportion of the cement mortar by volume shall be as follows:

For rendering coat, Cement : Sand = 1:5

For finishing coat, Cement : Sand = 1:3

Lime putty may be mixed in mortar for finishing coat at 10% of sand by volume.

**Waterproof Cement Mortar**

Waterproof mortar shall be made by mixing a waterproof agent into ordinary cement mortar. The Contractor shall be responsible for selection and quality of the waterproof agent and this shall be approved by the Engineer before use. The mixing and application shall be in accordance with the manufacturer’s instructions.

**Application**

The surface which are to receive a rendering coat shall be free from all laitance, scum, loose carbonate scale, loose aggregate dirt and other foreign matters. Concrete block, brick or stone surfaces shall be sufficiently and uniformly damped immediately before application of mortar. Concrete surfaces shall be kept thoroughly wet for 24 hours prior to the application of mortar.

Where shown on the drawings or directed by the Engineer, steel wire lath shall be fixed to the brick, concrete block or concrete walls before applying cement mortar plaster.

Cement mortar shall be used within 30 minutes from the time of mixing. Retempering shall not be permitted.

The total thickness of rendering plus finishing coat shall be 30mm for the floors and 20mm for wall. Cement mortar finish shall be trowel finished unless otherwise specified. When the finishing coat is applied, the entire surface of floor or wall shall be finished in one operation in order to minimise joint marks.
When expansion and control joints exist in the base structure, provision shall be made to prevent cracking of the mortar by inserting metal expansion beads within the coating thickness in a manner approved by the Engineer.

The finished surface shall be perfectly plumb or level as the case may be except where otherwise specified without any bulging, runs, bruises or stains.

After application of the finishing coat, the surfaces shall be kept continuously damp for not less than 48 hours and then allowed to become thoroughly dry. Moistening shall be started as soon as the surface has hardened sufficiently not to cause displacement or damage.
In Situ Concrete Chambers

In situ concrete chambers shall be constructed generally in accordance with Specification.

Chamber Covers and Slabs

Covers and slabs shall be the type, size and weight shown in the drawings. Care shall be taken to see that slabs are even so that the cover can seat without rocking.

Covers and frames shall be provided as shown on the drawings. The tops of the covers shall be flush at all points with the surrounding surface of paved areas or as directed in unpaved areas. Any slight adjustment of the slab level which may be necessary to accomplish this shall be effected by topping the side walls with concrete.
6.1.16. STONEWORK

**Stones**

Stone for all purposes shall be the best of its kind, sound and durable, free from flaws and from soft, weathered or decomposed parts. The stone and the quarry from which it is obtained shall be subject to the approval of the Engineer, samples shall be submitted by the Contractor of the stone he proposes to use in the Works and the Engineer’s approval shall be obtained before such stone is used or any order is placed. The stone used shall be clean and must be washed if deemed necessary in the opinion of the Engineer.

Stones for face work shall be as far as possible quarry split and not bullnosed or hammer dressed. A moderate amount of dressing to trim off large projections will however be permitted. Exposed faces of stones for masonry shall be free from tool marks except such as are inherent in the nature of any dressing that may be specified. In rock-faced work the roughness on the surface shall not project more than 40 mm for stone less than 0.3 m² face area and not more than 60 mm for large stones.

**Stone Masonry**

Masonry shall be built to the lines and levels shown on the Drawings.

For face work the stones shall show a face of not less than 0.025 m² and not more than 0.1 m² in area and none shall be less than 100 mm in depth; they shall be laid to give a uniformly random appearance and shall be selected in laying so as to present an even distribution of large and small stones on the face.

For the arises, stones shall be roughly squared, quarry split and of a size to give outbands varying from 300mm to 500mm in length and inbands from 150mm to 250mm. The alignment of arises shall be set true to the required lines.

The stones shall be set in mortar with their natural bedding plane (if any) as near normal as possible to the face or normal to the line of thrust in the case of load bearing structures. Particular care must be given to obtaining a sound bond both longitudinally and transversely and there shall be at least one bonder, or length not less than two-thirds of the wall thickness, in each square yard of wall face.

The mortar, unless otherwise specified, shall be machine mixed cement and sand in the proportion of one part to three (1:3) parts generally as described in the specification. Mortar shall completely fill all interstices between the stones.

The face joints in rubble masonry may vary in thickness from 10mm to 20mm. They shall be finished as a neat weathered joint with mortar while the work proceeds where the masonry is specified to be “unpointed”. Where pointing is specified, the joints in each day’s work shall be raked out to a depth of not less than 25mm before the mortar has set. Subsequently the joint shall be filled with mortar and finished in accordance with Clause 4.6. The face of the masonry is to be kept wet while the pointing is proceeding. Provision shall be made to clean all exposed faces both as work proceeds and on completion so that they are left in a neat, tidy and clean condition.

Building of masonry will not be allowed in heavy rain without the written consent of the Engineer. Building shall only proceed when suitable precautions to the satisfaction of the Engineer shall be taken against the action of rain on newly placed mortar. If for any reason of urgency the consent of the Engineer should be desired to a departure from these provisions, the Contractor shall submit to the Engineer for approval their proposals for protecting the materials and work from the weather.
Types of Masonry

The arrangement of the stones on the exposed face or faces of the masonry shall be as described below according to which type is called for on the Drawings.

Random rubble uncoursed masonry shall be built with stones of irregular shapes taken generally as they come from the quarry, preparation being limited to the removal of inconvenient corners and excrescences. They shall be selected as the work proceeds to give a uniformly random appearance and no attempt shall be made to form courses.

Random rubble masonry brought to courses shall be generally as the preceding type except that it shall be levelled up to courses between 300mm to 400mm in depth and coinciding with the quoin stones.

Squared rubble coursed masonry shall be built in courses between 100mm to 250mm in depth of stones squared to rectangular shapes and selected so that all stones in one course are of approximately the same height.

Bedding of Stone Masonry

Unless otherwise directed by the Engineer, all masonry stones, when incorporated in the Works shall be laid on its natural bed, except in the case of arches where the natural bed shall be radial.

Special Stonework

Special stonework shall consist of approved stones dressed to the shapes and dimensions and with the faces tooled, all as shown on the Drawings. All stones shall be laid true to line and centre with mortar joints as shown on the Drawings.

Pointing of Joints in Masonry

Unless otherwise shown on the Drawings, pointing to masonry joints shall be flush and shall be formed by raking the joint clean and then filling it with pointing consistency mortar which shall be given a flush face with a steel trowel.

Hand Placed Rubble Filling

Hand placed rubble filling shall consist of stones individually selected and placed by hand firmly in place in bearing contact with each other or with the sides of the space to be filled; the voids shall be carefully filled with small rocks and spalls wedged together to form a compact mass. The sides of stones shall be roughly trimmed if necessary with a spalling hammer to obtain a reasonably close fit. On the exposed face the stones shall be placed with their flattened sides uppermost and in the plane of the face.

Tipped Rock/Pitching

Rock protection on embankment slopes and around structures shall be to the lines and levels shown on the contract Drawings. The terms “tipped rock” and “pitching” refer to the manner in which the rock is placed.

The different classes of rock are specified on the Drawings according to nominal size and the maximum and minimum size of the individual particles. Within the size limits of each class, the rock fragments shall be well graded with not more than forty per cent (40%) of the rocks being smaller than the stated nominal size. The shape of the rock shall be roughly uniform with no dimension less than sixty percent (60%) of the largest dimension. The individual rock pieces shall be dense, durable and abrasion resistant.
The Contractor shall submit bulk samples of not less than 2m³ of each class of rock for approval by the Engineer prior to placing. These samples shall be retained for comparison with material being placed in order to ensure a reasonable degree of uniformity within each class.

The base on which rock protection is to be placed shall be compacted and trimmed to the lines and levels shown on the drawings. Where two or more classes of rock are specified, the lower layers shall be completed to the Engineer’s approval before the placing of subsequent layers.

Tipped Rock shall be tipped directly into place and roughly trimmed to the required profile. The thickness, lines and levels of each class of tipped rock is shown on the Drawings.

Pitching will be used where a finished horizontal or inclined surface is required. It shall consist of hand placed stones, with spalls wedged into the interstices to produce an even surface, without projection above the neat lines shown on the Drawings. Care shall be taken to ensure that the stones are well bedded and the percentage of spalls shall not exceed forty percent (40%) of the total rock volume. Pitching on slopes shall be built upwards from the toe, unless otherwise directed by the Engineer. A coping consisting of large flat stones shall be laid along the top of stone pitching on slopes to produce a firm edge.

Tipped Rock and Stone Pitching shall consist of selected hard durable rock free from weathered or decomposed parts to the approval of the Engineer, containing no flaky stone and being well graded within the limits shown below. The class and the thickness of the layer shall be as shown in Table below.

Classification of stone pitching materials

<table>
<thead>
<tr>
<th>Class</th>
<th>Size of stone d (mm)</th>
<th>Percentage by weight smaller than stone sized (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>300</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>125</td>
<td>40-50</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>63</td>
<td>40-50</td>
</tr>
<tr>
<td></td>
<td>31.5</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>63</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>60-85</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>20-40</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>31.5</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>50-80</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>20-50</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>350</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>F</td>
<td>225</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>35-55</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>G</td>
<td>850</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>30-60</td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>0</td>
</tr>
</tbody>
</table>

Tipped rock/stone pitching shall be placed in an approved manner in order to produce a uniform well knit unsegregated layer in which all sizes are held in position.

Gabions
Gabions shall be of the types and sizes shown on the Drawings. The cages shall be constructed from mild steel wire complying with BS 1052, “Specification for mild steel wire for general Engineering purposes”, galvanised in accordance with BS 443, “Specification for testing zinc coatings on steel wire and for quality requirements”. The wire shall be 3mm diameter formed into a fabric having a mesh of 75mm x 100mm for baskets and 60 mm x 80 mm for mattresses.

Stone filling for gabions shall consist of hard durable rock, free from weathered or decomposed parts. The minimum dimensions of each stone shall not be less than half its maximum dimension. For mattresses the stone shall be 200mm to 150mm for baskets the stone shall be 300mm to 200mm. The stone shall be obtained from a source approved by the Engineer. No stone shall be smaller than the size of the gabion mesh. In carrying out the filling, selected pieces of stone of elongated shape shall be placed with their flatter and elongated faces in contact with the mesh wherever possible.

The empty gabions shall be placed to line and level as shown on the Drawings or as directed by the Engineer and then stretched so that the gabions regain their shape on being filled. Diaphragms shall be provided at not more than 1m intervals for baskets and not more than 0.6m intervals for mattresses. A gabion shall not be completely filled until the adjacent basket or mattress has been half filled, unless otherwise directed, in order not to cause displacements from bulging during filling.

For baskets at least two horizontal connection wires shall be tied between front and back of the gabion in each 1m compartment, at a height of 300mm and 600mm from the bottom as the stone fill reaches these levels. Additional tie wires shall be provided if necessary and in no case shall the gabion basket bulge by more than 40mm. Where a continuous line of gabions is required, adjacent gabions shall be securely tied together at the top and bottom of the gabions with tying wire.

The gabions shall be filled to a level just sufficient to require the lid to be forced into place with a bar. The lid and all joints between baskets and between diaphragms and baskets shall each be tied down with a continuous running wire.

Where gabions are to be shaped, the shape shall be formed by folding the mesh internally and tying it with a continuous running wire.

All tying wire shall be galvanised and of same gauge as specified for the cages above.

The surface upon which gabions are to be laid shall be compacted to a minimum dry density of 95% of the maximum dry density (AASHTO T99).

**Geotextile Filter Cloth**

Geotextile filter cloth shall be made of non-woven polyester material with a minimum weight of 270g/m² and minimum thickness of 2.3mm.

The material shall be placed carefully on suitably cleared surfaces, such that tearing or piercing is avoided at all times.

Continuity at horizontal and vertical joins shall be achieved with a minimum overlap of 0.6m. Overlaps may be physically sealed using spot welds with an open flame and subject to approval of the Engineer. On a horizontal join, the new layer shall be placed on the outside and backfilling shall proceed carefully to ensure that full contact of the join overlap is maintained. On a vertical join, the new layer shall be placed on the inside, and backfilling shall proceed such that contact is first on the outside layer, thereby sealing the inside layer to prevent soil migration between the overlap.

**Graded Filters**

The filter shall consist of well graded natural or manufactured aggregate having the following graduation. In the following ratios, FM represents the filter material and BM the base material.
For graded filters of sub-rounded particles:

50% size FM

\[ R_{50} = \text{---------------} = 12 \text{ to } 58 \]

50% size BM
and

15% size FM
\[ R_{15} = \frac{1}{d_{15}} = 12 \text{ to } 40 \]

15% size BM

For graded filters of angular particles:

50% size FM
\[ R_{50} = \frac{1}{d_{50}} = 9 \text{ to } 30 \]

50% size BM

and

15% size FM
\[ R_{15} = \frac{1}{d_{15}} = 6 \text{ to } 18 \]

15% size BM

The filter material should pass a 7mm for minimising particle segregation and bridging during placement. Also the filter must not have more than five per cent (5%) of material finer than that passing a 60 micron sieve to prevent movement of fines within the filter.

The graded filters shall consist of stone graded to meet the requirements indicated in table below.

**Classification of Filter material**

<table>
<thead>
<tr>
<th>Class</th>
<th>Size of stone (d) (mm)</th>
<th>Percentage by weight smaller than stone sized (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>63</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>70-100</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>10-80</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0-25</td>
</tr>
<tr>
<td></td>
<td>1.4</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>64-100</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>15-64</td>
</tr>
<tr>
<td></td>
<td>0.009</td>
<td>0-025</td>
</tr>
</tbody>
</table>

The filter shall be placed in layers and tamped into place in such a manner that mixing between layers or between the filter material and the formation to be protected, shall not occur.
Care shall be taken to ensure that segregation of sizes does not occur. The minimum thickness of each filter layer shall be 250mm unless otherwise shown on the Drawings. Where the term “gravel backing” is used on the drawings or Bills of Quantities, this shall be taken to mean graded filter class A material.

**Hardcore**

Hardcore shall consist of broken rock, concrete or other approved hard material, clean and free from extraneous matter, having a maximum particle size of 100mm. It shall be spread and levelled, watered and compacted, and then blinded with a layer of fine material of grading 3mm to dust, watered and compacted all to the Engineer’s approval.
6.1.17. PIPEWORK

General

The Contractor shall construct pipelines to the lines and levels using grades, classes, or designs of pipe, bedding, haunching and surrounding as shown on the Drawings or directed by the Engineer.

Unless otherwise described in the Contract or agreed by the Engineer only one type of pipe shall be used within any individual length.

All materials shall be subject to the approval of the Engineer prior to procurement and delivery. Upon delivery, the Engineer shall inspect the delivered material for compliance with the specifications. In case of non-conformity, the Contractor shall replace the material at his own cost.

The pipes and fittings shall comply in all respects with Specified Standards and Kenya standards and jointing of pipes and fittings shall be carried out in accordance with the manufacturers’ instructions and to the approval of the Engineer.

Storage and Protection of Materials

The quality and quantity of materials used in the project shall be the entire responsibility of the Contractor and any damage, loss, defect shall be at the Contractor’s costs.

Pipes shall be stacked on a firm base using two timber packers only under the barrel of rigid pipes such as concrete.

Flexible pipes such as UPVC shall be stacked closely side by side on a firm plane base so that the whole length of the barrel is uniformly supported and sockets are clear of the ground. Each succeeding layer shall be placed at right angles to the previous layers. The height of any stack shall be not more than 4 (four) layers of pipes and in the case of steel, not more than two layers.

Each class and size of pipe shall be stored separately in its own stockpile.

Fittings and specials of any type shall be stored in a single layer only.

Pipes and fittings shall at all times be adequately protected from damage during transport, storage and handling. Cracked or chipped pipes shall not be used in the permanent works. Steel and large diameter plastic pipes shall be fitted in the factory with end caps or reinforcement adequate to prevent distortion during transport, storage and handling.

Plastic pipes and fittings shall be protected from direct sunlight and excessive heat. Deformed pipes and fittings shall not be used in the permanent works.

All elastomeric rubber rings or other materials that may deteriorate under the action of sunlight, ozone or inclement weather shall be stored in permanent shade in lockable weatherproof sheds. Care shall be taken at all times to prevent contamination of rubber or plastic products or other petroleum-derived solvents.

Granular bedding shall be stored on a firm impermeable base so that it does not become contaminated with deleterious matter.
Handling Pipes and Fittings

The quality and quantity of materials used in the project shall be the entire responsibility of the Contractor and any damage, loss, defect shall be at the Contractor’s costs.

Before any pipes are delivered to site the Contractor shall submit details to the Engineer of his proposals for handling pipes during transport, in store and during laying.

Pipes and specials shall only be transported on properly constructed or adapted vehicles containing correctly shaped and padded cradles or with strong, sawdust filled bags separating pipes and vehicle body. During transport and in store, pipes shall not rest on narrow traverse supports likely to cause damage to the pipe or its coating. Pipes shall not be unloaded from a vehicle by tipping or dropping.

Pipes, specials and fittings shall not be subjected to rough handling at any time. Under no circumstances shall they be dropped during loading or off-loading or be allowed to collide with one another. Any materials that have been dropped from a vehicle shall immediately be rejected for use on the Works. The same shall apply for any pipes found defective before laying.

The handling of any pipes exceeding 200kg mass other than by means of a crane is specifically forbidden. The Contractor shall maintain a suitable mobile crane on the Site and shall use it for all loading, unloading, transferring between vehicles and lowering into the trench of such pipes. The crane shall be fitted with a sling of ample width. Wire rope slings or hooks in the ends of pipes shall not be used for pipes or fittings of any diameter or mass.

In making arrangements for handling pipes, the Contractor shall take into account any recommendations made by the pipe manufacturer.

Where appropriate the requirements of this Clause shall apply to fittings and other components.

Cutting Pipes

The cutting of pipes for making up lengths shall be carried out by a method which leaves a clean square end.

Concrete pipes shall be cut with a concrete saw or by hand. If cut by hand the end of the pipes shall be trimmed even and square and if reinforced, the steel shall be cut flush with the face of the concrete. If instructed by the Engineer the exposed ends of the steel shall be protected with bitumen or a cement grout.

Steel pipes to be cut shall have the line to be cut clearly marked round the pipe. Cutting shall be carried out by cutting disc or by oxy-acetylene and the cut end shall subsequently be ground to the correct profile for the method of jointing in use.

Pipes and Fittings

Steel Pipes

Steel pipes and fittings shall comply with BS EN 10224:2003 or EN 10204.3.1.c Non-alloy steel tubes and fittings for the conveyance of aqueous liquids including water for human consumption – technical delivery conditions.

Pipe shall be either seamless, electric welded or submerged arc welded. However the manufacturing process shall not be beyond their allocated diameter ranges:
Steel Pipes

<table>
<thead>
<tr>
<th>Manufacturing process</th>
<th>Outside diameter range, mm</th>
<th>Thickness range, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seamless (S)</td>
<td>26.9 – 711</td>
<td>2.0 – 100</td>
</tr>
<tr>
<td>Electric Welded (EW)</td>
<td>26.9 – 610</td>
<td>1.4 – 16</td>
</tr>
<tr>
<td>Submerged Arc Welded (SAW)</td>
<td>168.3 - 2743</td>
<td>2.9 - 50</td>
</tr>
</tbody>
</table>

Seamless (S) pipe is formed by a method of hot working steel to form a tubular product without a welded seam. If necessary, the hot worked tubular product may be subsequently cold finished to produce the desired shape, dimension and properties.

Electric Welded (EW) pipe formed continuously from a steel strip with a longitudinal seam. This seam is joined by electric resistance or electric induction welding wherein the edges to be welded are mechanically pressed together and the heat for welding is generated by the resistance to flow of the electric current.

Submerged Welded pipe (SAW) formed from a steel strip with a longitudinal or helical (spiral) seam. The seams are then welded together by a coalescence of metals caused by heating them with an arc or arcs between a bare consumable electrode or electrodes. The arc and molten metal are shielded by a blanket of granular, fusible material on the work. Welding shall include at least one pass on the inside and one pass on the outside of the pipe.

Pipes shall not include welds used for joining lengths of steel strip together prior to forming except for helical welded pipe provided that such weld is made using the same method of welding as the helical seam.

Pipes shall not contain circumferential welds. Pipes shall not be manufactured on site.

Pipes formed from, plate, strip or coil shall have edges mechanically sheared before forming. In the case of pipes thicker than 10mm to be manufactured by the Submerged Arc Process (SAW), the edges of plate, strip or coil shall be chamfered by mechanical milling.

Pipe shall be delivered in 12m or 18m exact lengths for DN 250 and above and 6m exact lengths for DN 200 and below. The tolerances on pipe length shall be in accordance to Table 9 of BS EN 10224.

Unless otherwise specified, pipe shall be supplied with spigot and socket push-fit joints with elastomeric seals. The joints shall be flexible joints as defined in BS EN 805:2000 and the allowable angular deflection of the joints shall comply with the Class B limits given in Table 5 of EN 805.

Steel pipes and fittings larger or equal to DN 200 shall be internally lined throughout their entire length internally with either:

a. Fusion bonded epoxy to AWWA C213 (400 μm dry film thickness);

b. Solvent free liquid epoxy to AWWA C210 (400 μm dry film thickness);

c. Polyurethane to AWWA C222 (500 μm dry film thickness).

The materials and application process shall be subject to the Engineer’s approval.

Steel pipes and fittings smaller or equal to DN 150 may be lined in cement mortar to AWWA C205.

For steel pipes DN 500 and below, the external protection shall be fusion-bonded epoxy to AWWA C213.
Dimensions for fittings shall comply with BS EN 10224. In the case of fittings such as reducers, laterals and washout tees not covered in BS EN 10224, the dimensions shall comply with AWWA C208.

Calculation of thickness of bends and reinforcement of tees and laterals shall comply with AWWA C208 and AWWA M11. The Contractor shall submit details of such calculations.

Flange jointed pipes shall have flanges complying with BS EN 1092: 2002.

All steel flanged pipes and fittings shall be supplied complete with hot dipped galvanised bolts, nuts to BS EN ISO 1461 (minimum 305g/m²) and appropriate gaskets. Gaskets shall be EPDM rubber and conform to BS EN 681. They shall be suitable for potable water.

The Contractor shall make available to the Engineer the manufacturer’s certificates covering the chemical analysis and physical properties of each cast of steel used in the manufacture of pipes. In addition, a product analysis shall be conducted on the steel coils, plates, billet or blanks prior to pipe manufacture.

All pipes shall be hydraulically tested before leaving the factory to induce a hoop stress equal to 70% of the minimum yield stress pressure as specified in BS EN 10224.

All pipes shall be tested according to Table 14 of BS EN 10224 and at the frequency stipulated in Table above.

All tests shall be carried at the expense of the Contractor at the place of manufacture and the Contractor shall supply a signed certificate on delivery of the goods concerned giving results of the tests and certify that the goods concerned have been manufactured in accordance with this Specification.

**Galvanised Steel Tubes**

Galvanised mild steel tubes and fittings shall comply with BS 1387 Class B or “Medium Grade”. Threading for screwed and socketed joints shall be in accordance with the requirements of BS 21.

Joints shall be made with an approved pipe-jointing compound in accordance with the manufacturer’s instructions. Red lead compounds shall not be used. Joints in underground piping shall be coated with bitumen or other approved composition.

All underground sections of pipework to be protected against corrosion by treating with K1-60 bitumen emulsion primer, and wrapped with fibreglass and coated with two coats of bituminous tap coats all to manufacturer’s specification.

The bituminous paint is to be manufactured to ASTM D1187-82.

All fittings for galvanised steel water pipework shall be galvanised heavy weight fittings in accordance with BS EN 10241. All fittings shall be subject to the approval of the Engineer.

Brass or gunmetal fittings shall be subject to the approval of the Engineer.

**UPVC Pipes**

Unplasticized Polyvinyl Chloride (PVC-U) pressure pipes shall have outside diameters, laying lengths and wall thickness complying with KS-06-149 Part 2: 2000. Joints shall be of the spigot and integral socket type. Solvent weld joints are not permitted in buried PVC-U pipelines.

Fittings for use with PVC-U pressure pipe shall be manufactured from either PVC-U or cast iron with socketed joints and shall comply with ISO 727. Cast iron fittings shall be bitumen coated. Aluminium alloy fittings are not permitted. The metal adaptor fittings shall comply with ISO 4132
Valves

Gate Valves

Gate valves shall conform to BS 5163-1:2004. The valves shall be tested in accordance with BS EN 1074-2:2000.

- Non-return valves: BS EN 1074-3:2000
- Air valves: BS EN 1074-4:2000
- Hydrants: BS EN 1074-6:2004

All gate valves shall close in a clockwise direction and the direction of opening and closing shall be cast on the handwheels or valve casing with the words ‘OPEN’ and ‘CLOSE’ respectively. All gate valves shall be capable of being operated manually with a maximum applied torque of 100 Nm for valves with a nominal diameter less than 450mm. The Contractor shall ensure that the gate valves supplied are fitted with appropriate thrust bearing guides and gearing to fulfil these requirements, ensuring that when reduction gearing is employed, the gear ratio shall not exceed 4:1.

Isolating gate valves shall permit manual closing off of the raw water supply.

Butterfly Valves


The use of butterfly valves as main line valves shall not be permitted.

Check Valves (Non Return Valves)

Check valves shall comply with BS EN 12334:2001: “Industrial valves. Cast iron check valves.” The valves shall be tested in accordance with BS EN 1074-3:2000. The valves shall be installed in a horizontal position to avoid malfunctioning of the check.

Single Air Valves

Single air release valves shall be of the small orifice type and shall have bodies of cast iron. The inlet shall be 25mm diameter fitted with an isolating plug cock and shall be screwed in an 80mm diameter blank flange drilled and tapped to BS 21. Single air valves shall be of pattern and manufacture approved by the Engineer for the conditions under which they will operate, and be fitted with a pressure gauge tapping and plug. Floats are to be manufactured from high-density polyethylene. The valves shall be tested in accordance with BS EN 1074-4:2000.

Except where defined in the contract drawings, the Contractor shall request for approval by the Engineer to provide large orifice valves installed in such numbers and at such locations as will:

a) Prevent the entrapment of large volumes of air at any high point of the pipeline during its filling;

b) Permit lengths of pipeline between valves to be safely filled with water and emptied of all air in a time not exceeding 4 hours.

c) Prevent negative pressures exceeding 3 m vacuum occurring anywhere along the pipelines during surge conditions or emptying.

Small orifice valves shall be installed at every high point in a pipeline length (except where the high point is an open end within a structure with a free water surface) for the purpose of releasing air
under normal operating conditions. A high point in a pipeline length shall be defined as any of the following:

a) Any top access manhole cover or any abrupt rise of the pipeline, such as to cross an obstacle or similar;

b) any point to which the pipeline rises steadily in the direction of normal flow for a length greater than 750 m and to an average grade steeper than 1 in 500 and thereafter is level or falls below a level grade or long horizontal lengths greater than 750 m.

As a minimum requirement the size of air valves required should be such that the inlet area of the valve is not less than 1.25% of the pipeline cross sectional area. If the design requires a larger size, the design requirement shall apply. The following are minimum requirements:

**Double Air Valves**

Air release and vacuum break valves shall be of a compact, single chamber design with solid cylindrical high density polyethylene control floats housed in a tubular stainless steel body with stainless steel ends secured by stainless steel tie rods.

The valves shall have integral surge alleviation mechanisms that 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 before valve closure. All air valves shall be mounted in a chamber and installed with an isolation valve to enable servicing, including the removal of the air valve without shutting off the main. All air valves shall be fitted with a drain plug to be used for testing, drainage or leak detection.

The intake/discharge orifice area shall be equal to the nominal size of the valve.

The valve design shall incorporate an overpressure safety feature that will fail without an explosive effect. This feature shall consist of easily replaceable components such as gaskets, seals or the like.

The valves shall be tested in accordance with BS EN 1074-4:2000.

**Flow Control Valves**

Pressure and flow control valves shall be installed as shown on the Contract Drawings or as directed by the Engineer and be suitable for the operating conditions specified.

The basic valves shall be either of the pressure compensating globe valve design with externally arranged spring and diaphragm assembly or of the streamline two chamber concentric plunger and pilot valve regulating assembly enclosed within the valve body as required for the particular applications. Valve bodies shall be of a suitable grade of close-grained cast iron to BS EN 1561:1997.

Valves shall be sized such that the fully open capacity is more than adequate to accept the specified maximum flow at the minimum differential pressure.

The globe valve design shall have the main seat in the stream flow and an upper cylinder for the valve element control piston type and shall have the required number of bosses drilled and tapped to receive strainer unit, relay valves and pressure gauges. The cover plate shall include an air vent and lifting eyes. The main seat shall have a renewable element and the upper portion shall be in the form of a piston and the lower portion shall have a face ring and ported guide.

Valves shall be fitted with an external control relay system which shall be capable of controlling the required parameter of flow or pressure within + or -5 per cent of the set value. The relay system shall include connecting piping couplings and isolating valves to permit maintenance or replacement without interrupting supply.
The rate of response of opening and closing of the main valve shall be adjustable and means for external indication of the main valve element position shall be fitted.

The particular control system for the different duties shall be as specified below.

**Altitude Valves**

The main valve shall be controlled by a slave ball cock mounted in the controlled tank at top water level and connected to the valve operating mechanism by small-bore pipework. The level of the ball shall be adjustable in service so that the main valve is fully drop-tight closed when the water level in the tank reaches top water level.

**Flow Control Valves**

Flow control valves shall be designed to prevent the flow downstream rising above that specified in the Particular Specification or shown on the Drawings for the particular application, regardless of the operating pressures in the system upstream or downstream of the valve. The relay system valve shall be operated by the pressure differential measured across the main flow orifice which shall be fitted at the upstream end of the flow control valve.

**Pressure Reducing Valves**

Pressure reducing valves shall be designed to reduce a constant or variable inlet pressure to a predetermined constant outlet pressure, at flows varying from the maximum capacity of the valve to zero flow. Adjustment of the outlet pressure shall be made by a screw on the relay valve or by changing weights as appropriate. A pressure gauge indicating downstream pressure shall be incorporated.

**Pressure Sustaining Valves**

Pressure sustaining valves shall be designed to maintain the pressure in the pipeline immediately upstream of the valve at or above a preset value, irrespective of the flow and pressure conditions downstream of the valve. Adjustment of the upstream pressure shall be made by a screw on the relay valve or by changing weights as appropriate. A pressure gauge indicating upstream pressure shall be incorporated.

**Pressure Relief Valves**

Pressure relief valves shall be designed to prevent the pressure in the pipeline immediately upstream of the valve rising above a preset value. The valve shall remain closed at lower pressures. Adjustment of the pressure at which the valve opens to relieve pressure shall be made by a screw on the relay valve or by changing weights as appropriate. A pressure gauge indicating upstream pressure shall be incorporated.

**Float Valves**

Float operated valves shall comply with BS 1212 and BS 1968 and BS 2456 “specifications for float ball valves”.

Ball valves shall be the plastic diaphragm type or similar approved with seatings to suit the working pressure of 5 bars with plastic float to BS 2456 and internal overflow.

**Coating of Valves and Cast Iron fittings**

All valves and Cast Iron fittings shall be coated by the instructions of the manufacturer, the coating needs to comply with DIN 30677 and DIN 3476 or equivalent, the contractor must prove that the proposed alternative standard is equivalent with the specified standard.
Laying Pipes in Trenches and Headings

Immediately before pipes are placed in any trench, the bottom shall be cleared of all stones and other debris and shall be in a condition acceptable to the Engineer. Prior to placing in the trench, all pipes shall be inspected for damage. Damaged pipes which in the opinion of the Engineer cannot satisfactorily be made good shall not be used in the permanent works. End caps or discs placed on the pipes for protection during transit shall not be removed until immediately before the pipes are jointed.

Pipes shall be laid in straight lines unless otherwise shown on the drawings. No pipe shall deviate from the true line and level by more than 5mm. Pipes shall be firmly bedded throughout their length to the required alignment and level so that they are concentric at each joint. All pipes shall be suitably wedged, shored or otherwise restrained to prevent movement during testing and backfilling but such restraints shall not be left in place permanently unless instructed or agreed by the Engineer.

Pipes which are to receive a concrete bed and haunch or surround shall be set on suitable concrete blocks or bricks with a pad of hessian based damp proof course two millimetres thick interposed between the pipe and the block. Setting blocks shall not be used with other forms of bedding.

Unless otherwise agreed by the Engineer a close fitting brush or swap shall be placed in pipelines having nominal diameters of 650mm or less and shall be drawn forward progressively as pipe laying proceeds by means of a suitable rope which shall be threaded through each pipe as it is laid. Pipelines having nominal diameters greater than 650mm shall be kept clean by suitable means as pipe laying proceeds. No debris of any kind shall be allowed to remain in the pipeline. Where the pipeline has internal lining, persons entering shall wear rubber boots and equipment trolleys shall have rubber tyred wheels. Pipes and joints shall be kept free of dirt, mud and other deleterious matter at all times. If pipe laying is stopped at any time, a cap shall immediately be placed on the end of the last pipe laid to exclude dirt.

Suitable precautions shall be taken to prevent the floating of pipes due to flooding of trenches. If floating should occur, the whole of the pipe run affected shall be removed and trench prepared again. No pipes shall be re-laid in trenches which have flooded until the trenches and the pipes have been inspected by the Engineer. The Contractor shall be entirely responsible for the sufficiency of all temporary supports and side slopes to the excavations. The excavation shall be carried out in such a way as to maintain the stability of all roads and other adjacent structures or works.

Pipes having integral sockets shall be laid with sockets facing upstream unless otherwise agreed or instructed by the Engineer.

Pipes in headings shall be laid in accordance with the requirements of this clause but pipe lengths shall not exceed 1.5m unless otherwise agreed by the Engineer.

Pipes Laid on Natural Ground

Filling shall commence with selected fill consisting of easily compacted material from which all stones larger than 25mm and all lumps of clay larger than 75mm have been removed. The selected fill shall be deposited equally on each side of the pipe carefully compacted in layers not more than 150mm thick. Care shall be taken to ensure that no voids are left under the pipe. The filling shall be continued to a level of 300mm above the crown of the pipe.

In the case of steel, ductile iron and plastic pipes, the Contractor shall ensure that no distortion of the pipe takes place during the backfilling operation.
The remainder of the trench shall be filled with excavated material and compacted in 150mm thick layers by means of a vibrating plate compactor or a mechanical rammer. The trench shall be filled flush with the surrounding ground surface.

**Pipes laid on Granular Bedding**

Granular bedding material shall be placed and compacted generally on both sides of the pipe up to the horizontal diameter of the pipe. Care shall be taken to ensure that no voids are left under the pipe. Thereafter the selected fill shall be as described in Clause 5.8 above.

**Pipes with Concrete Bedding and Surround**

The configuration of the concrete bedding, surround or arch shall be as shown on the drawings including the location of reinforcement if any is required. Pipes to be set in concrete shall be supported as set out in Clause 5.7. Small diameter pipes in short lengths shall be supported behind pipe socket. Large diameter pipes and long lengths shall be supported on two packers.

After jointing and testing as set out in the appropriate parts of this section, concrete of the class shown on the drawings shall be carefully placed and compacted under the pipes making sure that no voids are left, and brought up to the configuration shown on the drawings. The Contractor shall ensure that the pipes do not float or are in any way disturbed during concrete placing. The remainder of the backfill shall be placed as set out in Section 2 of this Specification.

Where pipes, which are laid on a bed of granular material, are to be protected by a concrete arch, the laying and jointing shall proceed as set out in the appropriate parts of the Specification and granular material shall be brought up to the horizontal diameters of the pipes.

After testing, concrete shall be placed over the pipes to the configuration shown on the drawings and the remainder of the backfill shall hereafter be placed as set out in Section 2 of this Specification.

Flexible joints shall be formed in concrete beddings, arches or surrounds in the location shown on the drawings. Such joints shall coincide with the pipe joint in such a way that the end of the socket is flush with one face of the joint and the socket faces into the joint space.

Joints in concrete beddings, arches and surrounds shall be 18 mm wide unless otherwise instructed by the Engineer and shall be filled with a compressible material such as a sheet of cane fibre board or cork board. The material used shall be subject to the approval of the Engineer.

**Special Accessories for the Buried Pipe Network**

**Scope**

This section of the specification concerns the supply and installation of accessories for the buried pipe network at the locations shown on the approved Drawings or as directed by the Engineer.

The several parts of the accessories, as described below, shall be considered as a complete unit, which will serve to supply water to the hydrant outlets from the underground distribution network. Each part shall be fabricated by an internationally recognised manufacturer and shall conform to the conditions of operation, the characteristics, the testing and other requirements described below.

The several parts of the accessories, as described below, shall be considered as complete unit, which will serve to supply water to the hydrant outlets from the underground distribution network. Each part shall be fabricated by an internationally recognized manufacturer and shall conform to
the conditions of operation, the characteristics, the testing and other requirements described below.

The Contractor shall at the time and place required, submit to the Engineer proposals concerning the manufacturers selected by him for the supply of the accessories, accompanied by a detailed report, specifications and certificates showing that the proposed components have been successfully used in similar water supply systems, so as to prove that the proposed accessories conform to the requirements of this specification in a satisfactory manner.

Subsequent to the provision and acceptance of the proposals as above, the Engineer may agree to the use of the proposed accessories, but his consent cannot be interpreted in any case whatsoever, as relieving the Contractor of his responsibilities for the supply of accessories which shall prove adequate and efficient during the testing procedure and the operation of the network.

The Engineer reserves the right, on the other hand to reject the Contractor’s proposals if he finds them incomplete or vague or if the proposed accessories do not conform to the requirements of this specification.

In such a case, within a reasonable period, not longer than one month, after communication of the above decision of the Engineer to the Contractor, the latter is required to supplement and improve his original proposals and submit his revised recommendations.

If the Contractor fails to submit, within the above time limit, his final recommendations, or if the Engineer for the same reasons rejects these for which his original proposals were rejected, he is required to supply accessories, which will satisfy the Engineer. If, however, he does no agree and insists on supplying the accessories which he has proposed, he must deposit a guarantee to an amount equal to the value of these accessories. This guarantee will remain in the hands of the Employer until the final acceptance and will be forfeited to the latter if, during the test procedure and the operation of the network, it is ascertained that the accessories supplied by the Contractor are not satisfactory. It is understood that the Contractor is, in addition, required to fulfill all his other obligations for the restoration of all defective construction until final acceptance by the Engineer.

Acceptance Tests

Included with the specifications submitted by the Contractor, shall be copies of any relevant international standards to which the items are to be constructed. The Engineer reserves the right to request independent authenticated tests at the point of manufacture and also similar tests in situ under operating conditions. All costs shall be borne by the Contractor who will promptly replace any components which, in the judgement of the Engineer are found, either after testing or during operation and until final acceptance, as not conforming to the requirements of this Specification.

Measurement and Payment

Measurement shall be by assessing the number of satisfactorily installed and accepted accessories. Payment will be made for the number of accessories measured as described above and on the basis of the respective contract unit prices. Such prices and payment constitute full compensation to the Contractor for supplying, hauling, storing and installing the accessories, for paying patent rights, for furnishing the equipment, materials and labour required for installing and checking the operation of the accessories in accordance with the foregoing requirements, and for any other related expense even if not explicitly stated above but necessary for the complete and proper performance of the work and the satisfactory operation of the accessories.

Pressure Reducing Valves
In case there is a requirement for Pressure Reducing Valves, this will be to protect the installed pipelines against high pressures.

The Contractor shall submit to the Engineer proposals referring to the valves to be used and the name of the manufacturer with whom he intends to place the purchase order, accompanied by a detailed report, specifications and certificates showing that the proposed valves have been successfully used in similar cases so as to prove that the proposed valves conform to the requirements of this specification in a satisfactory manner.

Following completion of the construction of the pipe network, and prior to its final acceptance, the Engineer may demand the performance of tests to ascertain the efficiency and adequacy of the installed valves. To this effect, the Contractor shall, at his own expense, place at appropriate locations of the network to be designated by the Engineer automatic recording manometers with the minimum possible inertia of moving parts so as to ascertain in an unquestionable manner, the adequacy of the valves, especially during filling and draining of the network as well as on sudden opening and immediate shut down of a riser located at a relatively unfavourable point.

The Contractor shall take into account the fact that the valves must be “drop tight” or “sealed” at no flow conditions and that the seals and operating mechanisms must be proof against suspended solids in the supply water (untreated river water). The valves shall operate automatically, hydraulically, without electricity.

**Specifications for Mechanical Water Meters**

Contractors are expected to supply and install meters meeting the below specifications and fill the table giving details as attached.

<table>
<thead>
<tr>
<th>Technical specifications for</th>
<th>Tenderer's designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meters no. Mm</td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>No</td>
</tr>
<tr>
<td>1</td>
<td>General requirements &amp; description</td>
</tr>
<tr>
<td>1.1</td>
<td>Objective of the Particular Specifications (PS)</td>
</tr>
<tr>
<td>Meter type</td>
<td>1.1.1a</td>
</tr>
<tr>
<td>Ratio Q3/Q1 (=Qn/Qmin)</td>
<td>1.1.1b</td>
</tr>
<tr>
<td>Manufacturing norms &amp; regulations documented</td>
<td>1.1.2</td>
</tr>
<tr>
<td>Parameter</td>
<td>No.</td>
</tr>
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<td>-----------</td>
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</tr>
</tbody>
</table>
| 1.1.3     |     | General requirements & description | A water meter based on mechanical properties consists of:  
* A meter body (measurement chamber) which contains the measurement transducer;  
* A measurement transducer that contains the mobile parts used to determine the water volume (or the water flow) passing through the water meter;  
* A register (counter) that memorises and displays, mechanically or electronically, the water volume going through the water meter.  
The measurement transducer can be dissociated from the register, i.e. the measurement transducer (turbine or piston) is not physically connected to the register (calculator) via a shaft but via magnetic drive. Where that is the case, the design must guarantee the integrity of the entire water meter.  
A water meter based on the velocity type technology has a measurement transducer which consists of a turbine or a helix activated by the water velocity. A water meter based on volumetric type technology has a measurement transducer which consists of a piston. The number of rotations of the piston is contingent upon the volume of water flowing through the water meter.  
When the water meter is equipped with an electronic display register, it is called a “hybrid water meter”. |

| 1.1.4     |     | Upgradable to AMR | To allow a future upgrade to an automatic meter reading (AMR) system, the “equipped water meter” shall be fitted with one of the following auxiliary devices:  
* A radio emitter, called “module”, attached to the water meter or directly integrated to the register;  
* A pulse emitter;  
* An encoded output emitter;  
* An analogical output emitter.  
The equipped water meter shall be fitted with a compact device; attached to the water meter or directly integrated to the register.  
The pulse emitter shall be designed in such a way that:  
* In the event of back flow, the emitter discounts the pulses due to this back flow;  
* The water meter is impervious to magnetic fraud. | Yes/No | Document | Page | Line |
<table>
<thead>
<tr>
<th>2</th>
<th>Regulatory compliance &amp; standard certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Regulation pertaining to legal metrology</td>
</tr>
<tr>
<td>2.1.1</td>
<td>Further to a prior request from TCML, the Supplier shall provide documented proof that his products comply with all appropriate standards applicable to the location of their installation.</td>
</tr>
<tr>
<td></td>
<td>Comply with OIML R49</td>
</tr>
<tr>
<td></td>
<td>Yes/No</td>
</tr>
<tr>
<td></td>
<td>2.1.2</td>
</tr>
<tr>
<td></td>
<td>Certificate</td>
</tr>
<tr>
<td></td>
<td>Yes/No</td>
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<tr>
<td></td>
<td>2.1.3</td>
</tr>
<tr>
<td></td>
<td>2.1.4</td>
</tr>
<tr>
<td>2.2</td>
<td>Drinkability and Sanitary Conformity</td>
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<tr>
<td></td>
<td>Certificate</td>
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<td></td>
<td>Yes/No</td>
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<td>2.3</td>
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<td>documente d</td>
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<td></td>
<td>Yes/No</td>
</tr>
<tr>
<td></td>
<td>The manufacturing process and the materials’ composition shall comply with all applicable environmental standards, in particular with European directives CEM, WEEE, RoHS and DEEEE. The Supplier shall demonstrate his initiatives in the realm of sustainable development.</td>
</tr>
</tbody>
</table>
3 Metering and metrology

3.1 Metering precision

<table>
<thead>
<tr>
<th>Error curve</th>
<th>Yes/No</th>
<th>Metrological signature (table below)</th>
<th>Yes/No</th>
<th>Ability to be certified by laboratory</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Supplier shall provide the reference metrological signature (error curve) for each type of water meter. The metrological signature shall be established on a representative sampling of water meters using the testing flows defined in the following table. The water meters shall have the ability to be calibrated and verified by any certified laboratory (in liquid flow metering) without requiring the purchase of special equipment or the undertaking of special works.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>ND (mm)</th>
<th>Testing flows (litres/hr), with preferential flow ranges per size in red</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 3 5,5 11 22,5 40 80 150 300 700 1350 2400 2900</td>
<td></td>
</tr>
<tr>
<td>20 3 5,5 11 22,5 40 80 150 300 700 1350 2400 4750</td>
<td></td>
</tr>
<tr>
<td>30 11 22,5 40 80 150 300 700 1350 2400 4750 9500</td>
<td></td>
</tr>
<tr>
<td>40 22,5 40 80 150 300 700 1350 2400 4750 9500 19000</td>
<td></td>
</tr>
<tr>
<td>50 22,5 40 80 150 300 700 1350 2400 4750 9500 14250 28500</td>
<td></td>
</tr>
<tr>
<td>65 40 80 150 300 700 1350 2400 4750 9500 19000 42500</td>
<td></td>
</tr>
<tr>
<td>80 80 150 300 700 1350 2400 4750 9500 14250 28500 85000</td>
<td></td>
</tr>
<tr>
<td>100 150 300 700 1350 2400 4750 9500 19000 42500 85000 115000</td>
<td></td>
</tr>
</tbody>
</table>

3.1.2 Sensitivity to inertia

The water meter’s sensitivity to inertia after interruption of the water flow shall be minimal.

3.1.3 Stopping flow

The Supplier shall indicate the stopping flow (by decreasing flows) and the lowest flow for which the measuring error is above or equal to -20% (by increasing flows).

3.1.4 Documented

The Supplier shall prove that his water meters have a repeatability lower than one third of the maximal measuring errors tolerated by the standards.

3.2 Consistency of metrological characteristics

3.2.1 Yes/No

The variations in the metrological signature of the new water meters when compared to the curves provided by the Supplier shall comply with the following threshold values:
* ±0.75% between Q2 and Q4 or between Qt and Qmax;
* ±1.50% between Q1 and Q2 or between Qmin and Qt.

3.2.2 Documented

The monitoring of such variations shall be carried out every year by the Supplier on the entire set of water meters delivered to TCML or on an equivalent production.

3.2.3 Result of test & conclusion

The water meters shall have the ability to function to a peak flow (2 x Qmax or 2 x Q4) for a period of 1 hour. The variations of the metrological signature, before and after the test, shall comply with the aforementioned criteria in Art. 3.2.1. The Supplier shall provide in his technical proposal the results of such tests.
### 3.3 Water meters orientation

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>3.3.1</td>
<td>In the majority of situations, the water meters shall be installed horizontally. However, for divisionary metering, i.e. individual apartment metering for example, or in certain other specific situations, where ½&quot; or ¾&quot; water meters shall have the ability to be installed vertically or sideways.</td>
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<tr>
<td>3.3.2</td>
<td>Water meters based on the volumetric type technology shall maintain their performances (as approved by the regulations) in all installation positions.</td>
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<tr>
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<tr>
<td>3.3.3</td>
<td>For water meters based on the velocity type technology, a deterioration of their performances (as approved by the regulations) shall be allowed depending on the installation position. This deterioration shall be the lowest possible and shall require the prior approval of TCML.</td>
</tr>
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<td></td>
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<tr>
<td>3.3.4</td>
<td>Water meters that only work in one installation position shall not be accepted for diameters lower or equal to 50 mm.</td>
</tr>
</tbody>
</table>

### 3.4 Metrological ageing of the water meter

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>3.4.1</td>
<td>The Supplier shall provide with his technical proposal the proof that the design and manufacturing of his water meters minimises the degradation of their metrological characteristics with age and/or the volume of water transiting though the water meter.</td>
</tr>
<tr>
<td></td>
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<tr>
<td>3.4.2</td>
<td>The Supplier shall provide for each type of water meter an estimate of the degradation of the metrological signature with time. This estimate can be based on tests using scaling or accelerated wearing with sand.</td>
</tr>
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<td></td>
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<tr>
<td>3.4.3</td>
<td>The Supplier shall prove that the design of the water meter avoids over-registration that does not comply with regulations.</td>
</tr>
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<td></td>
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<tr>
<td>3.4.4</td>
<td>Water meters based on the specific velocity type technology called “Multi-Jet” shall not be accepted.</td>
</tr>
</tbody>
</table>

### 3.5 Water meter material

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>3.5.1</td>
<td>The materials used in the construction of the water meter 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. The meter body casing shall be made from materials with a life expectancy under normal use in excess of 20 years.</td>
</tr>
</tbody>
</table>
### 3.5 Water meter material

#### 3.5.2
The water meters shall 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 food grade, non-toxic and non-tainting as attested by a reputable and certified international laboratory. Water temperature variations within the working range shall not adversely affect the materials used in the construction of the water meter.

#### 3.5.3
For water meters designed for domestic use (DN15 – DN 20mm), the meter body shall be manufactured from a special thermoplastic material with highest technical characteristics suitable to replace the traditional brass and bronze materials, without any constraints neither in terms of metrology nor of pressure resistance.

#### 3.5.4
The measuring transducer shall be of high grade polymer to ensure minimum wear and a high degree of reliability.

### 4 Installation

#### 4.1 Dimensions

<table>
<thead>
<tr>
<th>[DN15mm only] Meter's dimensions</th>
<th>4.1.1</th>
<th>The dimensions of water meters equipped or not with a radio module shall be the smallest possible.</th>
</tr>
</thead>
</table>

#### 4.2 Installation condition

<table>
<thead>
<tr>
<th>Meters' installation speed</th>
<th>4.2.1</th>
<th>The physical installation of the water meters by TCML contractors shall be the fastest possible.</th>
</tr>
</thead>
</table>

| documented Yes/No | 4.2.2 | The equipped water meters shall be installed either:  
* In a meter box, manhole or chamber (using a support rail or not);  
* In a façade cubicle or compact meter box;  
* On an appropriate wall mount support. |
<table>
<thead>
<tr>
<th>4.2</th>
<th>Installation condition</th>
</tr>
</thead>
</table>
| 4.2.3 | Installations in a well designed meter box outside the property boundary shall be the preferred installation method. Exceptions may occur when the area is susceptible to regular flooding/silting. In those cases, above ground installations shall be accepted with the following conditions:  
* Within the property boundary to avoid tampering/vandalism/theft;  
* Venting mechanisms (air valves) are installed at high points to avoid the occurrence of air locks;  
* Shaded from direct sunlight to avoid deterioration of non metallic serviced pipes and excessive temperatures in water meter. |
| 4.2.4 | In order to facilitate their installation, water meters shall incorporate:  
* An arrow on the water meter body to identify the orientation corresponding to positive metering;  
* An appropriated grip device to facilitate the upstream and downstream mounting/dismantling operations;  
* A 2 mm hole used to seal the water meter with a sealing wire;  
* A clear, detailed and adapted installation notice included inside the water meter packaging; |
| 4.2.5 | The water meter shall have the ability to be installed without any deterioration of the meter body or the threads on metering points displaying non aligned (eccentric) upstream and downstream service pipes. |
| 4.2.6 | The water meter shall be free of any salient angles which can cause injury. |

<table>
<thead>
<tr>
<th>4.3</th>
<th>Fittings</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.3.1</td>
<td>The dimensions and threads shall comply with the ISO 4064 part 1.</td>
</tr>
<tr>
<td>4.3.2</td>
<td>The upstream and downstream connection points shall be identical. When installing the water meter, the threads shall not deteriorate or create leaks.</td>
</tr>
<tr>
<td>[composite only] 4.3.3</td>
<td>For water meters made of composite materials, solutions will be highlighted to avoid deterioration of the threads during installation/removal procedures.</td>
</tr>
<tr>
<td>[threaded meters only] 4.3.4</td>
<td>For water meters with threads, meter gaskets shall ensure correct water tightness with other fittings and gaskets provided by the Supplier;</td>
</tr>
<tr>
<td>4.3.5</td>
<td>Compact “all in one fittings” shall be preferred in order to optimise space and reduce the size of the meter box.</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>4.4</strong></td>
<td><strong>Check valve</strong></td>
</tr>
<tr>
<td>Documented</td>
<td>Yes/No</td>
</tr>
<tr>
<td></td>
<td>All water meters from DN 15 mm to DN 40 mm shall be provided with an inbuilt or additional if not inbuilt check-valve inserted inside the water meter’s downstream pipe. The check-valve shall comply with the requirements of the EN 13959 related to anti-pollution check-valves or with any other equivalent norm.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>4.5</strong></th>
<th><strong>Meter box (Not Necessary since meters will be in chambers)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>[DN15-20 only] Documented</td>
<td>Yes/No</td>
</tr>
<tr>
<td></td>
<td>Domestic water meters (DN15-20mm) shall be preferably installed in a meter box (refer to Article 3.2.3 above) with the following characteristics:</td>
</tr>
<tr>
<td></td>
<td>* The meter box shall be of an appropriate size to accommodate the two sizes of meters (DN 15 and 20). The meter box will have risers to allow installation at varying depths (existing service connections) and a box bottom;</td>
</tr>
<tr>
<td></td>
<td>* The meter box shall be made of a highly resistant composite material resistant to UV rays;</td>
</tr>
<tr>
<td></td>
<td>* The meter box lid shall be made of a non-metallic highly resistant composite material resistant to UV rays to enable the future implementation of AMR systems. The meter box lid should have a window allowing the customer/meter reader to read the meter dial;</td>
</tr>
<tr>
<td></td>
<td>* The water meter assembly shall be suitably keyed to prevent it from rotating during installation;</td>
</tr>
<tr>
<td></td>
<td>* The box must incorporate a lock mechanism, built into the lid. Locking mechanisms using screws shall not be accepted.</td>
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<tr>
<th><strong>4.6</strong></th>
<th><strong>Sealing</strong></th>
</tr>
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<tbody>
<tr>
<td>Measured sealing documented</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Sealing by corrosive resistant wire.</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Details of sealing wire type</td>
<td>Yes/No</td>
</tr>
<tr>
<td></td>
<td>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 mm diameter holes in the halves of the body, and secured by a circular sheet metal seal impressed by a device which provides a unique imprint on the seal. Suppliers shall provide details of the sealing wire type with proof of corrosive resistant and method proposed.</td>
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</tbody>
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<tr>
<th><strong>5</strong></th>
<th><strong>Conditions of use</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5.1</strong></td>
<td><strong>Environment</strong></td>
</tr>
<tr>
<td>Documented</td>
<td>Yes/No</td>
</tr>
<tr>
<td>5.1.1</td>
<td>The assigned conditions of use for the water meters shall comply with the following values:</td>
</tr>
<tr>
<td></td>
<td>* Maximal Admissible Pressure: 16 bars;</td>
</tr>
<tr>
<td></td>
<td>* Cold Water Temperature Class: T30;</td>
</tr>
<tr>
<td></td>
<td>* Air Temperature: between -10°C and +55°C.</td>
</tr>
<tr>
<td>Documented</td>
<td>Yes/No</td>
</tr>
<tr>
<td>5.1.2</td>
<td>The water meters shall be compatible with all types of pipes used by TCML.</td>
</tr>
</tbody>
</table>
## Conditions of use

| 5.1.3 | The water meters, equipped or not, shall have the ability to be installed without destruction for a period of fifteen years in the following testing environments: * In permanent immersion or fluctuating water levels; * In saline environments. |
| 5.1.4 | The list of critical components prone to damage/degradation that might cause metering errors outside of the regulatory thresholds shall be indicated by the Supplier. |
| 5.1.5 | The water meter shall resist external chemical aggressions common to potable water environments. |

## Fluid physico-chemical parameters

| 5.2.1 | The transported fluid is treated water for potable use. |
| 5.2.2 | The Supplier shall prove the resistance of his water meters to disinfection agents, like for example chlorine dioxide, within the limits of the thresholds set by regulations in relation to potable water. |
| 5.2.3 | The Provider shall submit in his technical proposal documented evidence of the resistance of his water meters to suspended particles, describing the devices used to diminish the risk of blockages. |

## Volume display and inscription

<p>| 5.3.1 | The height and the font of the letters shall facilitate the reading of the volume and the inscriptions. The minimal height shall be equal to 5 mm. |
| 5.3.2 | The Supplier shall use known methods to guarantee the perennial display of the volume and inscriptions readings. |
| 5.3.3 | The m³, which correspond to the billing basis, shall be indicated in black. The lower multiples of the m³ shall be indicated in red. |
| 5.3.4 | When using a mechanical register, m³ shall be indicated with rotating digits. |
| 5.3.5 | There shall be no occurrence of condensation or deposit in the register under the glass lens. Solutions to restore the visibility of the register and other parameters shall however be accepted. |
| 5.3.6 | For non-equipped water meters, volume and anti-fraud devices shall be visible from a distance of 1 meter. |
| 5.3.7 | The water meter’s register shall be rotatable, even when the meter is equipped, to facilitate the reading of the volume and other inscriptions. |</p>
<table>
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<tr>
<th>5</th>
<th>Conditions of use</th>
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</table>
| **documented Yes/No** | 5.3.8 | The identifying inscriptions of the water meter (meter body and register) shall be as follows:  
* Direction of flow on both sides of the meter;  
* Nominal flow rate (Qn or Q3) in m³/h;  
* Maximal Admissible Pressure: 16 bars;  
* Q3/Q1 ratio or Class;  
* Individual Serial Number Engraved;  
* Manufacturer’s Name;  
* Country of Manufacture;  
* Year of Manufacture;  
* Model Type; |
| **documented Yes/No** | 5.3.9 | When the water meter is equipped, it is accepted that part of the register display can be hidden. However, the billing digits (m³) shall remain visible. |
| **documented Yes/No** | 5.3.10 | Certain lower multiples of the m³ have to remain visible to allow in-situ verification of the water meter’s performance. The lowest visible lower multiple shall change of at least one unit when the water meter is working at Q₃/10 during one minute. |
| **documented Yes/No** | 5.3.11 | When the water meter is equipped, the following elements shall be easily read: the mechanical register, the serial number, the low-flow leak indicator and the regulatory inscriptions. |
| 5.4 | Resistance to fraud, vandalism |
| **documented Yes/No** | 5.4.1 | Water meters shall be resistant to fraud. However, it is accepted that fraud or fraud attempts be indicated and easily detected by TCML agents when reading the water meter. |
| **documented Yes/No** | 5.4.2 | Water meters with threaded extremities shall be equipped with a sealing device on the service pipe. |
| **documented Yes/No** | 5.4.3 | The Supplier shall provide in his technical proposal the tests carried out to prevent fraud or to detect it, particularly for the following types of fraud (if applicable): software frauds, magnetic, intrusion, electromagnetic, clamp-joint, hot needle. |
| 5.5 | Client comfort |
| **documented Yes/No** | 5.5.1 | The water meter shall allow the detection of low flow leaks: a flow equal to Q₁/₃ shall be detected in less than one minute. |
| **documented Yes/No** | 5.5.2 | The Supplier shall ensure that the water meters generate a low level of noise. The maximum noise value, in dB(A), shall be submitted by the Supplier for every type of water meters for sizes DN15 mm and DN 20 mm. |
| **documented Yes/No** | 5.5.3 | The permanent flow indicator of the water meter, equipped or not, shall always be visible. |
| 6 | Resistance against perturbations - Robustness |
| **documented Yes/No** | 6.1 | Maximum admissible pressure |
| **documented Yes/No** | 6.1.1 | The maximal admissible pressure is defined by compliance with the ISO 4064. The maximal admissible pressure shall be 16 bars. |
6.1.2 The Supplier shall prove that in case of sudden water pressurisation, the measuring error will be located within the range of maximal measuring errors tolerated by the regulations.

### Resistance against perturbations - Robustness

| Documented | Yes/No | 6.1.3 | For water meters sizes DN 15 mm and DN 20 mm, the measuring error shall be located within the range of maximal measuring errors tolerated by the regulations after:
|            |        |       | * Sudden pressure variations from 0 to 25 bars following 10 seconds cycles repeated 150,000 times (or any other test result offering the same guarantees);
|            |        |       | * Sudden water pressurisation with upstream pressure equal to 12 bars and downstream pressure equal to zero bars. |

### Headloss

6.2.1 The head-loss at Q4 shall be the lowest possible, particularly for water meters based on volumetric type technology.

6.2.2 The Supplier shall submit in his technical proposal the specifications for water meters that can be used for fire fighting installations.

### Sensitivity to Hydraulic Perturbations

6.3.1 The Supplier shall submit in his technical proposal the water meters’ class of sensitivity to the flow profile as defined by the ISO 4064, as well as the necessary installation conditions (upstream and downstream free lengths, stabilizer, etc.).

6.3.2 The Supplier shall submit in his technical proposal the results of tests carried out to determine the water meters’ sensitivity to other types of perturbations: butterfly valves, elbows, pumps, etc.

### Vibration and shock

6.4.1 The water meters, equipped or not, shall comply with the guidelines of the ISO 4064 in terms of mechanical behaviour.

6.4.2 The water meters, equipped or not, shall be designed to:
* Avoid any degradation during their transportation;
* Be installed on a pipe subjected to vibrations;
* Be installed next to low vibrating objects (for example a slammed door);

### Protection index

6.5 Water meters and auxiliary devices shall comply with the IP68 standard that consists of a submersion under 1 meter of water during 21 days.

### Influence of auxiliary devices

6.6 The auxiliary devices shall not deteriorate the metrology and the performances of the water meters on which they are installed.

### Customer care & Quality monitoring

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<thead>
<tr>
<th>Documented</th>
<th>Yes/No</th>
<th>7.1.2</th>
<th>Any other certification, for example ISO 17025:2005 or ISO 18001:2007, shall be favourably taken into consideration.</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Customer care &amp; Quality monitoring</td>
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</table>
| 7.1.3 | The Supplier shall highlight in his technical proposal the pre-established and current dispositions taken to manage the manufacturing process, particularly:  
* The list of controls and tests carried out during and at the end of the manufacturing process;  
* The external control by a certified body for aspects related to regulatory certifications and approvals;  
* The arrangements taken to measure the products’ performances after their commercialization  
* The procedures used to manage client’s claims and corrective/preventive actions taken. |
| 7.2  | Training & manufacturing |
| 7.2.1 | The Supplier shall describe the training arrangements proposed to TCML. Details of such training, additional costs if any and training programme shall be provided in the proposal. |
| 7.2.2 | The Supplier shall communicate in advance all the information related to planned modifications on the purchased water meters (nature of the modification, tests carried out, results and starting date), to allow TCML to validate these modifications prior to delivery. |
| 7.2.3 | The Supplier shall commit himself to pursue the sale of non-modified water meters should TCML not validate these modifications. The serial number and the change date shall be communicated by the Supplier. A technical monitoring sheet for the modifications shall be submitted to TCML. |
| 7.2.4 | The Supplier shall allow the visit of auditors designated by TCML to his sites. |
| 7.2.5 | The Supplier shall communicate in his technical proposal the modalities and tariffs in relation to the expertise of the register’s internal clock. |
| 7.2.6 | The Supplier shall describe in his technical proposal the means at his disposal for Customer Service. Addresses of Local Agents and details of after - sales - service shall be given. Information on stocks of meters, meter spares, workshop facilities, meter testing facilities, etc., with the Local Agents shall be provided; |
| 7.2.7 | The Supplier shall supply a full and compete list of all parts of the meters offered duly named (in English) and numbered together with the prices for each separate part. The normal usage and cost of the spares will be considered when assessing the cost of each meter which will be a factor in the selection of the Supplier. |
| 7.3  | Manufacturing monitoring |

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<table>
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<tr>
<th>Documented</th>
<th>Yes/No</th>
<th><strong>7.3</strong> Manufacturing monitoring</th>
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<tbody>
<tr>
<td><strong>7.3.1</strong></td>
<td>The Supplier commits himself to implement pertinent indicators, particularly for manufacturing, primary verification, delivery, and claims monitoring. These indicators shall be submitted after a preliminary demand from TCML.</td>
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</tr>
<tr>
<td><strong>7.3.2</strong></td>
<td>The Supplier will communicate to TCML at least every year a metrological balance (average and standard deviation) of the primary verification of water meters delivered to TCML or of a representative production. The Provider will also communicate to TCML every three months the metrological signatures (error curves) obtained with a representative sample of the production.</td>
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<tr>
<th>Documented</th>
<th>Yes/No</th>
<th><strong>8</strong> Conditioning and storage</th>
</tr>
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<tbody>
<tr>
<td><strong>8.1</strong></td>
<td>The Supplier shall highlight in his technical proposal the conditioning mode (wrapping, packaging, weight), by model or by diameter.</td>
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<tr>
<td><strong>8.2</strong></td>
<td>The water meters’ performance shall not be deteriorated during sea, air or land transportation.</td>
<td></td>
</tr>
<tr>
<td><strong>8.3</strong></td>
<td>The threads and pipe extremities shall be protected with appropriate devices. All protections shall be easily removable before the water meters’ installation. The water contained in the water meters shall not deteriorate the protection level offered by the conditioning, nor the internal elements of the water meters.</td>
<td></td>
</tr>
<tr>
<td><strong>8.4</strong></td>
<td>The Supplier shall communicate in his technical proposal the storage requirements and maximal storage duration in TCML stores, so that the water meters’ conserve their original performances.</td>
<td></td>
</tr>
<tr>
<td><strong>8.5</strong></td>
<td>Upon delivery, the conditioning shall include on the sides a summary of the water meters’ model and diameter, as well as the serial numbers.</td>
<td></td>
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<tr>
<td><strong>8.6</strong></td>
<td>The packaging sealing shall allow the detection of any previous opening attempt.</td>
<td></td>
</tr>
<tr>
<td><strong>8.7</strong></td>
<td>Upon delivery, the wrapping shall show (prior to its opening) traces of shocks or dents that may have damaged the water meters.</td>
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<tr>
<th>Documented</th>
<th>Yes/No</th>
<th><strong>9</strong> Warranty</th>
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<tr>
<td><strong>9.1</strong></td>
<td>The Supplier shall submit all documents that certify his responsibility for all “hidden defects” in materials and workmanship. For a period of 5 years starting at the delivery, the Supplier shall guarantee the correct performance of every element constituting the water meter following the standards of the current PS. Parts to replace the materials in which a defect may develop within the warranty 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.</td>
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</table>
Specifications for Electromagnetic Water Meters with possibility of upgrade to AMR

The contractor shall supply install and test three Electromagnetic meters (EMM), one in Ngurumani and another one at the water plant. The EMM meters will need to resist ambient temperatures of up to 46 degrees centigrade and shall be in concrete chambers. The meters will be equipped with an inbuilt or external data logger and the supplier will equally supply the software needed for reading the data loggers, either through USB cables supplied by supplier and or through telemetry through normal communication frequency provided by a local telecommunication company with good network connectivity within Magadi, Ngurumani area. This meters shall transmit flow readings at set intervals through dongle/modem to a stationary PC with appropriate software. This is to enhance monitoring of water supplies and consumption. The meter display can be mounted remotely at the water plant and above ground to overcome humidity. The meter in Ngurumani will be installed in a lockable chamber.

Power, communications and installation requirements

a) Power Supply

Long-life lithium battery minimum 8 - 10 years

Pressure and flow data logger

High resolution flow and pressure data logger with GSM modem, transmitter and receiver with required ancillaries and software

b) Wireless communication via optional built in GSM modem

Supply all materials including demonstration and training of operation staff on how to install, configure for use, download data and acquire data remotely and manually up to 30 km radius where frequencies allow between transmitter and receiver with no interruption or data gaps. These will be by either the following methods

- Remote access to logger data over quad-band GSM network by SMS text message
- Diagnostics and configuration, via standard GSM mobile phone
- Automated metering data reporting via SMS text

IP68 electronic package

- Zero water ingress, even during flood conditions
- Military specification IP68 plug and socket connections
- Sealed-for-life – maintenance free
- All circuit boards in the meter shall conform to temperatures minimum of 15 °C and maximum 48 °C
- All circuit boards in the meter shall conform to a minimum relative humidity of 75 % and a maximum relative humidity of 85 %

Battery power for remote locations

- Up to 8-year battery life
- Manganese alkaline or Lithium battery pack
- Site-replaceable battery pack
- The battery can be replaced without loss of logger contents enabling smooth switchover

Installation requirements

Installation requirement of zero pipe diameters (OD) upstream and downstream

Specification – Flow meter

Battery- or renewable energy-powered reduced-bore meters (FER) – flow specifications
Flanged meters

Electrodes – stainless steel 316L, all meters must be flanged and should be supplied with appropriate bolts and nuts of sufficient length to enable installation of the meters with all additional grounding rings, 6mm gaskets and as per the technical specifications on bolts and nuts, they shall be in compatibility with the flanged adaptors for the installation of the meters.

Pressure limitations

As flange rating

PN20 Max Process Temp 50 °C (122 °F)
PN20 Max Process Temp 40 °C (104 °F)
OIML / MID Approved Meters 16 bar (232 psi)

Pressure equipment directive 97/23/EC

This product should be applicable in networks for the supply, distribution and discharge of water and associated equipment and is therefore exempt.

Environmental protection

Rating:

IP68 (NEMA 6P) to 10 m (33 ft)
Buried (sensor only) to 5 m (16 ft.)

Temperature limitations

Ambient temperature

- Remote transmitter
  –20 to 70 °C (–4 to 158 °F)
- Close-coupled transmitter
  –20 to 60 °C (–4 to 140 °F)

Process temperature

- OIML R49 T50 approval
  – to 50 °C (32 to 122 °F)

Humidity limitations

The relative humidity in Mombasa is between 75 % and 85 %,

Conductivity

>50 μS /cm

End connections

40 to 1000 mm (1.5 in to 40 in.) flanged (FER), as per the description in the schedule of materials

EN1092-1 / ISO 7005 – PN10, PN16
ANSI B16.5 Class 150
AS 2129 Tables C, D, E and F
AS 4087 PN14, PN16, PN21
JIS to BS2210, 10k

Pipe conditions
Specification – Transmitter

Mounting
Remote up to 50 m with armoured cables resistant to distraction by insects

Housing
IP68 (NEMA 6P) < 2 m (6 ft)
Stainless steel housing in a thermoplastic outer cover with
Window, encapsulated with polyurethane-based resin.

Electrical connections
IP68 plug and socket, mains cable

Sensor cable
ABB cable supplied as standard or equivalent, must be submersible and armoured IP68

External battery pack
IP68 (NEMA 6P)
Manganese alkaline or Lithium battery life: 0 to 45 °C (32 to 113 °F) typically 5 years
Battery life is shorter to be used once per day for SMS automated reporting of data logged at 15 minute intervals, the allowable life of a battery pack to be reduced by not more than 20 %

Backup power time
Approximately 1 minute

Pulse and alarm outputs
Three, bidirectional, solid-state switches with common isolation ±35 V DC 50mA
Output 1 – forward only or forward plus reverse pulses
Output 2 – reverse pulses or direction indicator
Output 3 – alarm indicates any problem with measurement or with power
Pulse output – 50 Hz maximum, 50 % nominal duty cycle

Communications options
Only meters that are supplied complete with compatible with GSM loggers and support PC software will be accepted for this contract
Serial data communications
Local Port RS232
RS485 MODBUS
MODBUS RTU slave
Baud rates:
1200, 2400, 4800, 9600 or 19200
RS485:
2-wire + ground signalling
Low power shut-off mode after 10 s of inactivity

Telemetry applications

GSM / SMS modem
Mounting: Internal
Frequency bands:
Quad band: 850 / 900 / 1800 / 1900 MHz
Functions: SMS auto report of flow and optionally, pressure logger data (1 s or 1 min. average)
SMS report frequency: typically daily
SMS alarm reporting at time of event, for example power loss, limited to 1 per day
SMS flow meter configuration
SMS flow meter diagnosis
SMS total / tariff auto report

Response time (programmable)
Minimum 60 s (battery-powered + external renewable energy)

Device languages
English
Pressure system – external transducer
Pressure range not less than 16 bar Abs
Connection
Standard quick-fit male probe connector via an adapter cable
Operating temperature range
−20 (ambient) to 70 °C (−4 to 158 °F)
Protect the sample and transducer from freezing.
Accuracy (typical)
±0.4 % of range
Thermal error band (typically 100 °C [212 °F])
±1.5 % span

Cable length

5 or 10 m (16 or 33 ft)
5.12 Joints in Pipelines

Rigid Joints

When laying rigidly jointed pipelines with pipes having integral sockets, before entering a pipe spigot into its socket, both spigot and socket shall be clean and free from mud, oil, grease or other deleterious matter. A gasket of tarred hemp yarn, cut to length so that it forms a butt joint at the crown of the pipe shall be wrapped round the spigot which shall then be fully entered into the socket and the gasket caulked up hard into the joint. The joint shall then be filled completely with a plastic mortar composed of one part of cement to two parts of sand.

The pipes shall not be pressure tested or disturbed in any way for at least 48 hours after jointing.

Rigidly jointed sleeves used to join two spigots shall be jointed in the same manner as integral sockets.

If the drawings require ogee jointed pipes to be laid with a mortar joint, the joint shall be made at the time of laying. Mortar as described above shall be applied to the lower semi-circumference of the socket and to the upper semi circumference of the spigot and the pipe shall be drawn hard into the socket. Excess mortar squeezed out of the joint shall be removed from both the inside and outside of the joint.

Flexible Joints

Flexible joints between pipes having integral socket may be formed by a shaped rubber gasket fitted within the socket or by EPDM rubber ring of circular cross section (O-ring) placed on the pipe spigot. The type of flexible joint to be used shall be subject to the approval of the Engineer and shall be made strictly in accordance with the manufacturer’s recommendations.

UPVC Pipes

Unplasticized Polyvinyl Chloride (PVC-U) pressure pipes shall have outside diameters, laying lengths and wall thickness complying with KS-06-149 Part 2: 2000. Joints shall be of the spigot and integral socket type. Solvent weld joints are not permitted in buried PVC-U pipelines.

Fittings for use with PVC-U pressure pipe shall be manufactured from either PVC-U or cast iron with socketed joints and shall comply with ISO 727. Cast iron fittings shall be bitumen coated. Aluminium alloy fittings are not permitted.

The metal adaptor fittings shall comply with ISO 4132.

Steel Pipes

These shall be caulked in thread seal for rigid joints. Flexible joints incorporating rubber O-rings shall be made in accordance with the manufacturer’s instructions. Joints incorporating bolted or screwed glands or couplings shall be made in accordance with the manufacturer’s instructions.

Components of flexible joints from different manufacturers shall not be used together.

Connections to Existing Pipelines

Where a connection is to be made to an existing water pipe other than that at a chamber, a pipe saddle or a normal Tee of the correct size shall be used for this purpose and to suite the site condition and piping needs. In case of a saddle the hole in the pipe shall be cut precisely by either wet or dry tapping to fit the saddle and shall require the Engineer’s approval.

Saddles for UPVC pipes shall be complying to KS-06-149 Part 2-2000 and shall be fixed with a solvent in accordance with the manufacturer’s instructions.
Pipes through Structures

Where a pipeline passes into or out of a structure, including a manhole cover or similar chamber, two flexible joints shall be formed. The flexible joint shall consist of a 500mm long pipe section connected along the main pipe, with the nearest end 500mm from the face of the structure. One joint will be made on the incoming pipe and another joint on the outgoing pipe.

When the structure is less than one pipe length wide, the above requirement shall not apply and a sleeve shall be formed through the structure so that there is a clear space at least 75mm wide all-round the pipe. Adequate means shall be provided to prevent soil from entering this gap.

Pipelines within Concrete Structures

Sections of pipelines which are to be cast into concrete may be installed in advance of the remaining parts of the pipeline subject to the agreement of the Engineer. Such sections shall be placed accurately into position and fixed so that they can not move during placing of concrete around them.

Pipes under Roads

All pipes at the crossing of driveways and roads shall be surrounded with concrete for the entire length of crossing before trench backfilling.

Concrete surround shall be approved by the Engineer on satisfactory compliance with protection of pipes as detailed in Section 5.9.

Cleaning

The insides of all pipes, valves, tanks and fittings shall be clean, smooth, and free form blister, loose scale and dirt when erected. All lines shall be cleaned after all installation work.

When pipes are installed all ends shall be suitably plugged until final fixing of fixtures can be carried out. Pieces of cloth or stone will not be permitted.

Pressure Testing of Pipelines

As the installation of the pipework proceeds, the various sections shall be tested before they are built in, concealed, or finally connected. The Contractor shall advise the Engineer in writing at least three days in advance of the carrying out of such tests, and such tests shall, if considered necessary by the Engineer, be carried out in his presence.

All tests shall be at the expense of the Contractor and it shall be the responsibility of the Contractor to make all necessary records of the tests and results and submit these to the Engineer in the final form agreed.

All pipe systems shall be tested hydraulically for a period of one hour to not less than one and a half times the design working pressure. Testing shall comply with BS EN 805:2000 for standard field testing of pipelines.

If preferred, the Contractor may test the pipelines in sections. Any such section found to be satisfactory need not be the subject of a further test when the system has been completed, unless specifically requested by the Engineer.

During the test, each branch and joint shall be examined carefully for leaks and any defects observed shall be made good by the Contractor and the section re-tested.

Prior to testing any pipeline, the Contractor is to have “pulled through” as specified elsewhere. The pipeline may be tested in individual sectional test lengths. The required test pressures will be as directed by the Engineer.
Before any length of main is charged with water, each pipe in that length shall be covered to a depth sufficient to prevent uplift. The necessary backfilling shall be as specified in such a manner as to leave each joint completely clear for inspection during testing unless directed otherwise by the Engineer. If necessary or of required by the Engineer, each joint shall be timbered to retain the backfill.

On completion of mainlaying and sectional testing and before leaving the site, the whole pipeline shall be subjected to an overall comprehensive pressure test as directed by the Engineer. The approval of the Engineer is to be sought for the testing arrangement before the tests commence.

Where required by the Engineer, distribution pipes shall be tested against spherical ball valves.

Pressure testing shall be carried out as follows:

a. Gauges used for testing pressure pipelines shall either be of the conventional circular type, not less then 200 mm diameter, calibrated in metres head water, or shall have a digital indicator capable of reading increments of 0.1 m head. Before any gauge is used, the Contractor shall arrange for it to be checked independently and a dated certificate of its accuracy shall be provided.

b. Before testing, valves shall be checked and blanked off, the sections of main filled with water and the air released. After having been filled, pipelines shall be left under operating pressure for 24 hours unless instructed otherwise by the Engineer, so as to achieve as stable as possible for testing.

c. The pressure in the pipeline shall be raised steadily until the specified test pressure is reached in the lowest part of the section, and the pressure shall be maintained at this level, by pumping if necessary, for a period of one hour. The pump shall then be disconnected, and no further water shall be permitted to enter the pipeline for a further period of one hour. At the end of this period the original pressure shall be restored by pumping and the loss measured by drawing off water from the pipeline until the pressure as at the end of the test is again reached.

d. The permission loss shall not exceed 2 litres per metre nominal bore per kilometre length per metre head (calculated as the average head applied to the section) per 24 hours.

e. In addition to the test on separate sections, the whole pipeline shall be tested on completion to the same pressure and by the same procedures as that outline for individual sections.

f. Where a new pipeline is to connect to an operational pipeline the final connection shall be inspected visually under normal operation pressure and there shall be no visible leakage.

The test pressure referred to in previously shall be 10 Bar when testing against spherical ball valves in communication pipes or as identified elsewhere in the Contract Documents.

The Contractor is to include for all and every cost involved in carrying out the tests as instructed by the Engineer.

The Engineer or his Representative shall be given 24 hours notice that a length of main is ready for interim and final testing.

Initially, the test lengths will not exceed 300m but as the Works proceed and if it becomes established that the adopted method of laying and testing etc. is providing satisfactory test results, then it is anticipated that the actual test lengths will be progressively increased up to lengths not exceeding 100m where appropriate. To ensure that the testing of the main is not allowed to lag behind the pipe lying, no pipe laying will be allowed to progress more than one test length beyond the point to which a satisfactory test has already been obtained.
In the case of short sections of pipe laying on development sites, the Contractor may be required to test each section immediately after it is laid.

On completion of a main, the whole length of the main shall be subjected to a final test under pressure with all valves along the length of the main fully open.

For the duration of the test, valve gland packings shall be tightened down and re-adjusted on completion of the successful test.

During pressure testing, air valves shall be isolated. Testing will not be permitted against closed line valves or washout valves.

Water for filling the main for the initial sectional tests and the final completion test will be provided free of charge by the Employer but the Employer will not be liable for any expense which may be incurred by reason of inadequacy of pressure or failure of the supply. Water for retesting shall be charged for at the current meter rates.

The Contractor shall take all reasonable precautions to prevent any undue wastage of water, and shall provide, fix, maintain and work all necessary storage tanks, pumps, pipes, cocks, fittings, hoses and other appliances as necessary.

The Contractor shall give 24 hours notice to the Engineer of a request for inspection of the main under test. The Contractor shall bear his own costs and delays incurred by failure to meet this requirement or failure to have the main under test available for inspection upon expiry of the 24 hours.

The Contractor shall be solely responsible for costs and deployment of his labour, equipment and materials during the period of notice and test, and no claims for extra payment for unproductive time in this period shall be made.

Coating of Exposed Pipes and Fittings

All metal surfaces within chambers shall be mechanically wire brushed to remove all loose scale, grease etc. Within two hours of cleaning the coating shall be applied as specified in clause 5.6.8.

Preparation and application of the coating system shall be strictly in accordance with the Manufacturer’s instructions.

This clause shall not be applied to chemically or thermally bonded coatings on steel pipes.

Marker Posts

Precast concrete marker posts shall be set in concrete and fixed near valves, fire hydrants, washouts, changes in direction of the mains and where directed by the Engineer. The posts shall be detailed as directed by the Engineer and as per the technical drawings.
6.1.18. STEELWORK

General

Except where otherwise specified, structural steel shall be grade 43, complying with BS 7668, “Specification for weldable structural steels”.

All structural rolled steel members shall comply in dimension, weight and tolerance with that shown on the drawings and with BS 4, “Structural steel sections” and BS EN 10056, 10067 and 10210.

Bolts, Nuts and Fastenings

pipework or fittings with flanges shall be supplied drilled coupled with Bolts, studs, nuts and washers etc, which shall be of mild steel unless otherwise specified. The dimensions and tolerances of nuts and bolts shall comply with BS 4190, “Specification for ISO metric black hexagon bolts, screws and nuts” or where specified to BS 3692, “Specification for ISO metric precision hexagon bolts, screws and nuts” and the threads shall be to BS 3643, “ISO metric screw threads”. The heads of the bolts shall be forged out of the solid bar and the ends shall be cleanly cut with standard threads and the nuts must fit the bolts accurately and tightly. Washers of the shape and type indicated on the drawings shall comply with BS 4320, “Specification for metal washers for Engineering purposes”.

Where nuts, bolts and washers are required to be galvanized, the galvanizing shall be to BS 3382, “Specification for electroplated coatings on threaded components”.

Electrodes

Electrodes used in welding mild steel shall comply with the requirements of BS 639, “Specification for covered carbon and carbon manganese steel electrodes for manual metal-arc welding”.

Contractor’s Shop Drawings

Where the Contractor is required to undertake the detailed design of the steelwork components, he shall provide the Engineer with copies of detailed shop drawings for approval at least fourteen (4) days before commencing fabrication. The Contractor shall be responsible for the detailed design of all connections and these shall be fully detailed on the shop drawings together with all dimensions, clearances, welding details and procedures, machining, marking, etc. The Contractor shall not commence fabrication until he has received the Engineer’s written approval of the shop drawings. Approval of such drawings shall in no way relieve the Contractor of his responsibility for accuracy or the correct operation of the component.

Fabrication and Erection of Steelwork

The standard of workmanship and Engineering practices to be adopted for fabrication and erection shall conform to BS 449, “Specification for the use of structural steel in building” and BS 5531, “Code of practice for safety in erecting structural frames”.

The Contractor shall supply samples of materials and standards of workmanship as required by the Engineer. All samples approved by the Engineer shall be retained and shall be considered as setting the standard for all subsequent work.
Inspection of work will be carried out by the Engineer and the Contractor shall give sufficient notice of the date when fabricated steelwork is ready for inspection. The Contractor shall provide particulars of places and dates of manufacture of all materials for the Permanent Works and the names of the manufactures. Copies in duplicate of all orders for materials shall be sent to the Engineer at the time of placing such orders.

The Contractor shall ensure that all foundation bolts and supports including built-in bolts, etc upon which the steelwork is to be erected are in the correct position and that the steelwork fits correctly in required positions without forcing or straining in any way. Any check by the Engineer of the Contractor’s measurements shall not relieve him of his responsibility for obtaining this fit unless any errors in position are clearly not attributable to him.

No permanent bolting or site welding shall be done until proper alignment has been obtained. The Contractor may use temporary jigs, anchors or supports during erection, but must allow for thermal movement to take place freely at all times.

If the Contractor wishes to drill holes in or fix attachments to the steelwork to carry temporary work such as shuttering, he shall obtain the Engineer’s approval of the positions and details of all such holes or attachments and shall close such holes and remove the attachments to the satisfaction of the Engineer.

On completion of erection of any part of the steelwork on which the Contractor wishes to add further works, such as roofing, he shall first obtain the Engineer’s approval of the steelwork and remedy any defects required by the Engineer. Any approval given shall in no way relieve the Contractor of his responsibility for ensuring the subsequent correct positioning and behaviour of the steel work of other parts of the structure.

Welding

All shop welds shall be carried out by qualified welders who shall be under competent supervision. All welding is to be carried out in accordance with BS 5135, “Specification for arc welding of carbon and carbon manganese steels”. The Contractor’s proposals for welding shall be submitted to the Engineer for approval before any work is undertaken.

The Engineer may call for a test of a welder’s capabilities in accordance with BS 4872, “Specification for approval testing of welders when welding procedure is not required”.

In the case of site welds, the welding procedure for making each type of joint shall be approved by the Engineer before the work is commenced and the Contractor shall make such trial welds as the Engineer may require to demonstrate the soundness of the proposed method and the competence of his workmen.

Where site welding is used all welded joints shall be subject to inspection by the Engineer. Any welds that are in the opinion of the Engineer defective shall be cut out and the welds remade to the satisfaction of the Engineer. The cost of such corrective measures including any resultant delays shall be borne by the Contractor.

Coating General

The Contractor shall submit to the Engineer for his approval details of the types and manufacturers of coatings he is proposing to use, together with the manufacturer’s recommendations concerning preparation of surfaces, primers and undercoats, application methods, safety precautions and drying times for each type of coating. All paints used in the Works must be supplied ready-mixed in unbroken, sealed containers, which clearly show the type, colour and manufacturer of the paint and carry detailed “instructions for use”.
All metal surfaces on which paint is to be applied shall be blast cleaned as laid down in BS 7079, “Preparation of steel substrates before application of paints and related products”, or other mechanical means and fully prepared in accordance with the manufacturer’s recommendations. Applications of paint coatings on external work shall not be carried out or continued in mist, rain or excessively damp conditions. The Contractor shall take all necessary precautions to prevent dust and dirt coming into contact with freshly applied paint before it has dried.

Paints shall be applied either by brushing or spraying in accordance with the manufacturer's instructions. The thinning of paints shall not be permitted without the approval of the Engineer. Unless otherwise recommended by the manufacturer, the minimum interval between the application of a first coat of paint and the second shall be twenty four hours (24 hrs). Special care shall be taken to ensure complete coverage of all corners, arises and openings without causing an excessive build-up of paint and avoiding runs.

Steelwork to be painted shall be clean and free from all rust, grease, oil and mill scale.

**Coating Steelwork Immersed in Water**

Steelwork subject to immersion in water shall be blast cleaned or thoroughly mechanically cleaned by an approved alternative process and immediately coated before leaving the factory with zinc phosphate or similar compatible metallic inhibitive primer with a minimum dry film thickness of 50 microns. Following drying of the primer, the steelwork shall be coated with one coat of non-toxic, non-tainting, high build bituminous paint to BS 3416, “Specification for bitumen-based coating for cold application, suitable for use in contact with potable water”, having a minimum dry film thickness of 100 microns.

After erection, damaged areas of steelwork shall be mechanically cleaned and touched up with primer and bituminous paint to fully restore the factory applied coating system and thickness.

Finally, two overall finish coats of bituminous paint with a minimum dry film thickness per coat of 100 microns giving an overall minimum dry film thickness of the complete coating system of 350 microns.

**Coating other steelwork**

Where steelwork, which is not galvanized and not subject to immersion in water is required to be coated, it shall be thoroughly cleaned and painted prior to leaving the factory with:

One coat of zinc phosphate or similar compatible metallic inhibitive primer with a minimum dry film thickness of 50 microns. One coat of red lead primer with a minimum dry film thickness of 50 microns.

Two coats of micaceous iron oxide undercoat paint with a minimum dry film thickness per coat of 50 microns. After erection, damaged areas of steelwork shall be mechanically cleaned and touched up with primer and under coat to fully restore the factory applied coating system and thickness.

Finally, one overall finish coat of enamel gloss micaceous iron oxide paint with a minimum dry film thickness of 50 microns giving an overall minimum dry film thickness for the complete coating system of 250 microns.
Galvanising

All steel and ironwork of whatever kind required to be galvanised is to be pickled in dilute hydrochloric acid and then washed, fluxed and stoved and coated with zinc by dipping in a bath of molten zinc. All components are to be immersed in the bath only for the time sufficient for them to attain the temperature of the bath, they are then to be withdrawn at such a speed that a coating of 80 microns thickness is achieved, or such other practical maximum thickness for the component as defined in ISO 1461:2007, “Specification for hot dip galvanised coatings on iron and steel articles”.

The galvanising is to be carried out after all drilling, chipping, trimming, filing, fitting and bending operations are complete and shall cover all faces evenly.

After erection of galvanised steel components, damaged or welded areas shall be painted immediately after cleaning with two coats of metallic zinc primer with each coat having a thickness of 50 microns. The paint shall be applied strictly on accordance with the manufacturer’s instructions and shall be compatible with any subsequent coating systems to be applied.

Galvanised Handrails

Handrail tubes shall be 38mm nominal diameter steel tube to BS 1387, “Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads”. The top and bottom rails shall be 900mm and 450mm respectively above floor level. The rails and vertical standards shall be connected using screwed steel pipe fittings to BS 1740, “Specification for wrought steel pipe fittings (screwed BS 21 R-series threads)”, where practical with the final connections being welded in accordance with specification.

The handrail assembly shall be securely mounted on base plates fabricated of mild steel and attached to the base or foundation slab in a manner to be approved by the Engineer.

All sharp edges and rough areas shall be carefully ground off and the entire handrail assembly cleaned and galvanised in accordance with Clause 6.10.

Gates

Gates of the types and sizes shown on the drawings shall be supplied and installed where indicated on the drawings. The gate, shall be drop-tight and shall be suitable in all respects for use in raw water. The gates shall have flush inverts.

Gates shall be supplied complete with all frames, cills, gates, seals, spindles, handwheels and headstocks as required.

The frames and gates shall be fabricated in galvanised steel.

All gates shall have rising spindles with protection tubes, headstock, handwheel etc. and intermediate supports where the spindle is longer than 1500mm. Intermediate guide brackets are to be located 600mm above the gate frame, 400mm below the base of the headstock and at a maximum spacing of 1500mm, to suit or as recommended by the manufacturer and as approved by the Engineer.

Stop logs

Where shown on drawings the stop-logs shall be hardwood of the stated dimensions and shall be approved by the Engineer before supplying to site. Where shown on the drawings stop-logs shall be bolted to steel frames of stated dimensions to form hardwood gates.
6.1.19. ROADWORKS

General

Temporary Fences and Barriers

All boundaries of the Contractors offices, work-yards, workshops, depots and stores shall be agreed with the Engineer. A proper fencing, including lockable gate, shall be provided by the Contractor along the agreed boundaries.

The Contractor shall erect similar fences around all construction sites before commencing work, and dismantle them after the Works has been completed.

The fencing shall be in close-boarded timber, aluminium or steel corrugated sheets 2400 mm high fixed on timber, concrete or steel posts. All fenced areas shall be provided with lockable gates. In some of the areas agreed with the Engineer, the Contractor may provide chain link fencing or galvanized wire netting.

Traffic Requirements

Before any work in, or affecting the use of, any highway or road is commenced, the Contractor’s proposed method of working, including any special traffic arrangements, shall be agreed with, and confirmed in writing to, the Engineer and the Highway or Roads, and Police Authorities.

Throughout the Contract, the Contractor shall co-operate with the Highway or Roads, and Police Authorities concerning works in, or access to, the highway or road. The Contractor shall inform where necessary in writing, the Engineer, of any requirements of, or arrangements made with, the Highway or roads, and Police Authorities.

Barriers shall be fixed around trenches in streets and pedestrian areas and properly sign posted. All barriers on roads and pedestrian areas shall be lit with warning lights during night time or when there is poor visibility.

Where the diversion or closure of any existing carriageway, footway or public right of way is temporarily necessitated by the Works, the Contractor shall provide and maintain an alternative, which shall be operational before interference with the existing way.

Where ramps are required, they shall be provided and maintained to a standard suitable in all respects for the class or classes or traffic or pedestrians requiring using them.

Earthworks

Earthworks shall be carried out in accordance with the requirements of Section 2 of this Specification.

In carrying out the earthworks, the Contractor shall take all necessary precautions to avoid damage to or deterioration of the earthwork materials. He shall so arrange his work that water, which is brought onto or enters the earthworks at any time either in advance of or during construction shall be rapidly dispersed until the permanent work is completed.

Formation Level

Formation level on embankments and in cuttings shall be the surface level of the ground obtained after completion of the earthworks.

Preparation and Formation
Tata Chemicals Magadi Limited

August 2016

The formation to carriageways and verges shall be prepared to the satisfaction of the Engineer, well cleaned, free from mud and slurry, properly shaped and compacted by rolling to an even and uniform surface as shown on the Drawings or directed by the Engineer. Where soft pockets become evident during rolling, they shall be removed and replaced with sound compacted material.

Unless directed otherwise by the Engineer the formation shall be covered by the sub-base within 48 hours after the preparation the formation.

Once the formation has been prepared, constructional traffic, other than that specifically required for subsequent roadwork operations, shall not be allowed to run thereon without the permission of the Engineer.

Gravel Wearing Course

On completion of the road formation the Contractor shall lay sufficient gravel wearing course over the full width of the carriageway to achieve the consolidated depth and camber shown on the drawings or as directed by the Engineer.

Gravel wearing course shall consist of suitable natural gravel obtained from borrow pits approved by the Engineer and complying with the wet sieve analysis given below:

Wet Sieve Analysis

<table>
<thead>
<tr>
<th>BS Sieve size (mm)</th>
<th>Percentage passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>37.5</td>
<td>100</td>
</tr>
<tr>
<td>20</td>
<td>95 – 100</td>
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<tr>
<td>10</td>
<td>65 – 100</td>
</tr>
<tr>
<td>5</td>
<td>45 – 85</td>
</tr>
<tr>
<td>2.36</td>
<td>30 – 70</td>
</tr>
<tr>
<td>0.60</td>
<td>20 – 45</td>
</tr>
<tr>
<td>0.075</td>
<td>10 – 30</td>
</tr>
</tbody>
</table>

The gravel wearing course shall also comply with the following requirements:

- 4 day soaked CBR 20
- Plasticity Index 25
- Plastic Modulus 500

The CBR shall be determined in accordance with BS 1377 Test 16 on a sample compacted to 95% of maximum dry density as determined by BS 1377 Test B and then soaked for 4 days.
The material shall be spread in a uniform layer across the full width of the construction. The thickness of the layer shall be such that after compaction the thickness shall not exceed 150mm. Where a greater final thickness is required the material shall be laid and processed in two or more equal layers.

The material shall be mixed to a uniform consistency and any oversize materials shall be removed to an approved spoil dump.

The work area shall be kept continuously drained and any damage caused by water accumulating on or running off the surface shall be made good.

If necessary, water shall be added to bring the moisture content to between 80% and 105% of the optimum moisture content as determined by AASHTO 99 prior to commencing compaction.

**Compaction of Gravel Wearing Course**

All rolling shall be carried out longitudinally along the carriageway commencing at the carriageway edges and working in towards the centre. Material is to be compacted to 95% of the centre. Material is to be compacted to 95% of its maximum dry density or such other percentages as indicated on the drawings. Maximum dry density shall be as determined by AASHTO T99.

The in-situ dry density of the compacted material will be determined by the sand replacement method described in Test No 15A in BS 1377 or such other test as the Engineer shall consider appropriate. Each layer of fill material shall be approved by the Engineer prior to the placing of subsequent layers. Where the material is too wet or too dry the Contractor shall have the option of collecting the moisture content by watering or drying as appropriate, or modifying his compaction procedure so as to obtain the required dry density.

**Rehabilitation of Existing Access Roads**

**General**

The provisions of Clause 2 shall apply save where expressly varied hereunder.

All interventions shown on strip maps provided are subject to confirmation by the Engineer on Site.

**Site Clearing**

The width and length over which site clearing is to be carried out shall be as instructed by the Engineer.

**Spoil of Unsuitable Material**

This shall be in situ material, which is unsuitable to remain in the road, and has been instructed by the Engineer to be spoilt. Unsuitable material shall be deposited in spoil areas located by the Contractor subject to the approval by the Engineer. The rate for spoil shall include for the cost of excavating the material, loading, transporting, depositing, spreading and levelling the material in a spoil area, all to the satisfaction of the Engineer.

**Earthworks Fill**

The Contractor shall supply from a source approved by the Engineer, place and compact suitable borrow material having a minimum CBR of 10%, at 95% compaction as determined by AASHTO T99 to areas that require to be raised or where there is a deficiency of in situ material for reshaping.

**Light Grading**
Where this term is instructed, the road shall be graded to redistribute the existing material as required to achieve the specified cross section of the road, watered and compacted. This item applies where the required movement of material is not greater than 1m$^3$/m

**Heavy Grading**

The Contractor shall scarify the road surface, add fill material where required, reshape and compact to achieve the specified cross section. This item applies where the required movement of material is greater than 1m$^3$/m

**Gravel Stockpiling**

No separate measurement shall be made for stockpiling gravel and the Contractor will be deemed to have allowed for the costs elsewhere in his rates.

**Overburden Removal**

The removal of vegetation, topsoil and overburden at gravel borrow pits shall not be paid for separately. Contractor will be deemed to have allowed for the costs elsewhere in his rates. The same applies to any works required to access the borrow pits.

**Haulage**

The rate for gravel wearing course includes for the supply of material inclusive of extraction, loading and transportation to Site for a maximum haulage distance of 30km. Where suitable gravel is not available within this distance, overhaul will be paid for. Measurement shall be the product of the volume of compacted material in situ and the haulage distance in excess of 30km, one way, along the shortest route, as determined by the Engineer.

**Drainage Works**

**Culvert installation**

This shall include the provision and installation of a specified internal diameter including excavation and backfill to a compaction of 95% of maximum dry density as determined by AASHTO T99. The backfill material is to be approved by the Engineer. The rate includes any provisions necessary for diversion of traffic.

**Mass Concrete, Beds and Surrounds**

Unless otherwise shown on the drawings, the concrete shall be class C20/20

**Mitre Drains and Catch Water Drains**

These will be formed at the locations and the lines and levels shown on the drawings or instructed by the Engineer.

**Side Drains**

These will be formed to the lines and levels as shown in the drawings and at locations as instructed by the Engineer. Material excavated from the side drains may be incorporated into the reshaped road if suitable. Otherwise, it shall be spoiled in approved spoil areas.

**Cleaning of Existing Drains**
Tata Chemicals Magadi Limited
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The Contractor shall clean existing blocked culverts and clear side drains as may be directed by the Engineer.

**Repair of Existing Drains**

The Contractor shall replace broken culverts, and repair or reconstruct broken wingwalls and headwalls as directed by the Engineer.

**CONSTRUCTION TOLERANCES**

The following are the tolerances within which the works are to be executed or as directed by the Engineer:

**EARTHWORKS**

- Top level of Embankments after compaction: +100/-0mm
- Sides of over a 10 m length: +100/-0mm
- Channel or Excavation cutting: +20/-20mm
- Channel Water Way Area: -0
- Horizontal Alignment of Channels: Maximum Over 20m length: 300mm
  Minimum: 100 mm
- Formation Level for Structures: +0/-ve filled with concrete
- Formation Level for Gabions: +0/-100mm

**CONCRETE STRUCTURES**

The following tolerances shall apply to all wrought formed and fair or fine unformed finishes.

**Tolerance from Specified Position**

- Maximum departure of plan position of structure: 150mm

**Tolerance from Specified Dimension**

- Maximum departure in thickness, cross-sectional dimension or position of columns, beams, walls, footings and the like: +25/-10mm

**Surface Tolerance on Straightness or Departure from Specified Curve**

**General Surfaces**

- Maximum deviation in horizontal or vertical direction
  - gradual over a 10m length: 25mm
  - abrupt: 10mm
Surfaces in Contact with Flowing Water

Maximum deviation in direction of flow or normal to flow gradual over a 10m length 15mm

abrupt 5mm

Reinforcement

Maximum departure in required spacing 15mm

Minimum lap length shall be:

In the case of mild steel reinforcing 40 times bar diameter
in the case of high yield steel reinforcing 50 times bar diameter

Stonework

Pitching and Masonry over a 2 m length +100/-25mm
Face of gabion basket +75/-25mm
Thickness of tipped rock or filter layer +100/-0mm
7. BILLS OF QUANTITIES

7.1. GENERAL DIRECTIONS

In this Bill of Quantities, the sub-headings and item descriptions identify the work covered by the respective items. The exact nature and extent of the work to be performed shall be ascertained by reference to the Drawings, Specification and Conditions of Contract, as the case may be read in conjunction with the matters listed against the relevant headings in the Preamble.

The Tenderer is required to check the numbers of the pages of the Bill of Quantities and should any be found missing or in duplicate or figures or writing indistinct, the Tenderer must notify the Employer at once and have the matter rectified before the Tender is submitted. No liability whatsoever will be entertained in respect of any claim for errors in the Tender resulting from failure to comply with the foregoing.

The quantities of work and material set forth in the Bill of Quantities are an estimate only and are not to be considered as limiting nor as extending the amount of work to be done and material to be supplied by the Contractor. The Works as completed in accordance with the Contract shall be measured and paid for as described in this Bill of Quantities and in accordance with the Conditions of Contract and Specification.

The brief descriptions of items given in the Bill of Quantities are purely for the purpose of identification and in no way modify or supersede the detailed descriptions given in the Conditions of Contract and Specifications. As such, when pricing items, the Tenderer is to make reference to the Conditions of Contract and Specifications for the full directions, description of the work and materials.

The rates and prices entered in the Bill of Quantities shall be deemed to be the full inclusive value of the work described by the several items in the Drawings, Specification and Conditions of Contract including the following unless expressly stated otherwise.

- Labour and plant and all costs in connection therewith
- The supply of materials and goods to site, including costs for purchase, transportation, storage, wastage and any other charges
- Constructional Equipment and all costs in connection therewith
- Fixing, erecting, installing or placing
- All Temporary Works
- Compliance with all conditions, liabilities and risks involved in the execution of the works set forth or reasonably implied in the documents on which the Contract is based
- Establishment charges, overheads and profit
- Locating existing services
- Contractor’s accommodation, buildings and services (i.e. water, security, transport, welfare, etc)
- Testing and commissioning of the pipeline and the intake works diversion channel rehabilitation

Measurement

The measurement of work shall be computed net from the Drawings unless stated otherwise in the Method of Measurement for completed works.
Use of Alternative Materials or Designs

Where in the Contract a choice of alternative materials or designs is indicated for a given purpose, the description billed and rates inserted shall be deemed to cover any of the permitted alternative materials or designs which the Contractor may elect to use.

Unpriced Items

The cost of items which do not have a price or rate entered against them in the Bill of Quantities shall be deemed to be covered by the rates and prices entered against the remaining items in the Bill of Quantities.

General Attendance

General Attendance in connection with Nominated Sub-contractors shall include for affording the use of existing work space, access, temporary roads, erected scaffolding, working shelters, staging, ladders, hoists, storage, latrines, messing, welfare and other facilities existing on Site and the provision of protection, water, telephone, electricity for lighting, and clearing away rubbish and debris arising from the work.

7.1.1. Definitions

- “Conditions of Contract” means the Conditions of Contract contained in these Documents.
- Words and expressions defined in the Conditions of Contract shall have the same meaning herein.
- “Provisional Item” means an item describing work, the requirement for which is uncertain at the time the Tender documents are issued and which can only be carried out on instruction of the Engineer.
- The word “work” includes work to be carried out, goods, materials and services to be supplied, and liabilities, obligations and risks to be undertaken by the Contractor under this Contract.
- The expression “expressly required” means shown on the Drawings, described in the Specification or ordered by the Engineer pursuant to the Contract.
- “Bill of Quantities” means lists of items giving brief identifying descriptions and estimated quantities of the work comprised in the Contract.
- “Daywork” means the method of valuing work on the basis of time spent by the workmen, the materials used and the Equipment employed.
- A hyphen between two dimensions means a range of dimensions which includes all dimensions exceeding that preceding the hyphen but not exceeding that following the hyphen.
- “Existing Ground Surface” means the surface of the sludge or ground before any work has been carried out.

7.2. Progress Payments

Progress payments in the Interim Certificates referred to in the Appendix in respect of sum items in the Bill of Quantities shall be by means of interim progress instalments, such instalments not exceeding in aggregate, the total of each sum item. Such interim progress instalments shall be assessed by the Engineer based on the extent that the work to be done or liabilities or charges to be incurred by the Contractor under the description of each item bears to the extent of such work, liabilities or charges actually carried out under each sum item from time to time.
Abbreviations used herein shall have the following meanings:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>Millimetre(s)</td>
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</tr>
<tr>
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<td>Hectare(s)</td>
</tr>
<tr>
<td>m³km</td>
<td>Cubic metre(s) x kilometre(s)</td>
</tr>
<tr>
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<td>L.S.</td>
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<tr>
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<td>Prime Cost Sum</td>
</tr>
<tr>
<td>Kshs.</td>
<td>Kenya Shillings</td>
</tr>
<tr>
<td>Pcs</td>
<td>Pieces</td>
</tr>
</tbody>
</table>

**7.2.2. MEASUREMENT NOTICE**

Items whose units of measurement are time based shall not be measured:

- between the end of the time for completion or extended time for completion of the Works and the date of completion of the Works as described in the Contract;
- after the expiration of the Maintenance Period where services are required as a consequence of the default of the Contractor.

Payment to the Contractor for Items shall be the actual sum expended by the contractor as substantiated by receipts/invoices. However in each case such a sum shall not exceed the sum inserted against the corresponding item in the Bill of Quantities.
### 7.3. ITEMISED BILLS OF QUANTITIES FOR THIS CONTRACT

**Bill No. 1: Preliminaries**

<table>
<thead>
<tr>
<th>Item no.</th>
<th>Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Rate</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
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<td><strong>Preliminaries</strong></td>
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<td>2</td>
<td>Performance Bond/Guarantee</td>
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<td>Insurance of the Works, Contractor’s Equipment and Third-Party Insurance</td>
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<td>4</td>
<td>Preparing all contractor's documents, e.g. including but not limited to shop drawings and all as-built documentation.</td>
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<td>5</td>
<td>Provide and equip Engineer’s offices</td>
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<tr>
<td>6</td>
<td>Provide and maintain Contractor’s office, workshop, laboratory, all equipment, accessories and personnel necessary for full mobilisation of the site</td>
<td>Month</td>
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<td>7</td>
<td>Provide diversion road where necessary</td>
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<td>8</td>
<td>Provide for traffic control and maintenance of diversion roads where necessary.</td>
<td>month</td>
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<td>9</td>
<td>Operational Assistance during Defect Notification Period.</td>
<td>month</td>
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<td>10</td>
<td>Mobilization and Demobilisation including complete clearing of the Site</td>
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**Total for Bill No. 1**

(Carried Forward to Grand Total)
### Sampu Water Supply Rehabilitation - Phase 1

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<td><strong>INTAKE WORKS</strong></td>
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<td>Install Gabion boxes (10x4x2) at intake to stabilize diverted water for community supply</td>
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<td>Gunny bags for bolstering diversion works to intake channel</td>
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<td>8” Flanged Metallic strainer 6 mm mesh with non-dismantling cleaning outlet/flushing mechanism coupled with stainless steel bolts, nuts and washers</td>
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<td>8” Flanged UPVC/GI Adoptors coupled with bolts and nuts</td>
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<td><strong>MAIN LINE REHABILITATIONS</strong></td>
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<td><strong>Air Release Valves</strong></td>
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<td>50 mm flanged single orifice air release valves, PN16 coupled with stainless steel bolts, nuts and washers</td>
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<td>50 mm flanged gate valve coupled with bolts, washers and nuts and 6mm gasket</td>
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<td>100 mm x 100mm x 25 mm PVC Tee PN16</td>
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<td>25 mm PVC Valve socket PN 16</td>
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<td>25 mm GI Female threaded single orifice air valves</td>
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<tr>
<td><strong>Mains Water Meters</strong></td>
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<td>150mm Flanged Metallic Water Meter, Class B PN16, coupled with stainless steel bolts, nuts and washers</td>
<td>pcs</td>
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<tr>
<td>150mm Flanged Metallic Strainer with non-dismantling flush mechanisms and 6mm aperture strainer mesh, coupled with stainless steel bolts, nuts and washers</td>
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<td>80 mm Flanged Metallic Strainer with non dismantling flush mechanisms and 6mm aperture strainer mesh, coupled with stainless steel bolts, nuts and washers</td>
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<td>80 mm Flanged Sluice Valves, coupled with stainless steel bolts, nuts and washers</td>
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<td>Class C PVC pipe</td>
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<td>Couplings 150 mm Internal Diameter</td>
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<tr>
<td>3/4&quot; X 1/2&quot; GI reducer PN16</td>
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<td>1/2&quot; GI Elbows PN16</td>
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<tr>
<td>jet Class B</td>
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<td>1/2&quot; pegler gate valve (genuine)</td>
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<tr>
<td>DESCRIPTION</td>
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<td>1/2” GI nipple</td>
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<tr>
<td>1/2” GI socket</td>
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<tr>
<td>nuts and washers</td>
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<td>150mm PVC pipe</td>
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<td>150 mm metallic Ranger couplings (Schittal)</td>
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<tr>
<td>nuts, washers and 6mm gasket</td>
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<td>150 mm metallic strainer, with flushing mechanisms and 6mm mesh/aperture</td>
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<td>C.W.P at Oloiborto offtake to Sampu and Sampu line</td>
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<td>GI reducing socket 80mm x 25 mm (1”)</td>
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<td>1” GI Bends</td>
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<tr>
<td>1” GI Elbows</td>
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<td>1/2” x 800 mm GI threaded riser</td>
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<td>1” x 1/2” GI reducer bush</td>
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<td>1” GI pipe Class B</td>
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<td>1/2” mechanical water meter with inbuilt strainer and meter liners on both</td>
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<td>ends single jet Class B</td>
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<td>1/2” Peggler gate valve (genuine)</td>
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<td>1/2” GI double end threaded nipple</td>
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<td>1/2” GI socket</td>
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<td>Leaking Section before Lengubay</td>
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<td>4” mm GI Sockets</td>
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<td>Pipes)</td>
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<td>Lengubay</td>
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<tr>
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<td>Servicing the valve</td>
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<td>1” water meter with inbuilt strainer and meter liners on both ends single</td>
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<td>jet Class B</td>
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<td>1” Peggler gate valve</td>
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<tr>
<td>1” GI nipple</td>
<td>pcs</td>
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<td>1” GI socket</td>
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<td>1” PPR pipes PN16</td>
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<td>4” Flanged sluice valve coupled with bolts, nuts and washers, PN16</td>
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<td>4” Flanged PVC/GI Adoptors</td>
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<td>1” Ball valve for all tanks (Different Tanks)</td>
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<td>1” Elbows</td>
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<td>Rukungo</td>
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<td>1/2” push tap</td>
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<td>1/2” elbow</td>
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<td>1/2” x 0.8 m GI Riser double threaded</td>
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<td>1/2” metallic water meter, Class B, with inbuilt strainer and coupled with</td>
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<td>meter liners, PN16</td>
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<td>1/2” GI Nipples</td>
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Tata Chemicals Magadi Limited
August 2016
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<td><strong>Loldoi</strong></td>
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<td>1&quot; Elbows</td>
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<td>1&quot; x 1/2&quot; GI reducer</td>
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<td><strong>Valve and Meter Chambers</strong></td>
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<td>Supply materials and Construct 1m x 1.5 m x 1m Masonry meter chambers as per standard drawings attached</td>
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<td><strong>Oloika</strong></td>
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<td>50 mm threaded GI pipe Class B</td>
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<td>50 mm GI Sockets</td>
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<td>50 mm 45 °GI Elbows</td>
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<td>50 mm 11.25° GI Elbows</td>
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<td><strong>GRAND TOTAL FOR PLUMBING MAINTENANCE WORKS/ASSET REHABILITATION COMMISSIONING AND TESTING</strong></td>
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