

**IRRIGATION DEPARTMENT
GOVERNMENT OF BALOCHISTAN**



BIDDING DOCUMENT

FOR

**PROCUREMENT OF GOODS FOR CONSTRUCTION
OF SIBI WATER SUPPLY SCHEME**

**BALOCHISTAN INTEGRATED WATER RESOURCES
MANAGEMENT AND DEVELOPMENT PROJECT (BIWRMDP)**

NCB NO. : PK-PMU-BIWRMDP-353693-GO-RFB

**PURCHASER : PROJECT DIRECTOR
BALOCHISTAN INTEGRATED WATER RESOURCES
MANAGEMENT AND DEVELOPMENT PROJECT**

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COUNTRY : PAKISTAN

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PART ONE (FIXED)

- INSTRUCTIONS TO BIDDERS (ITB)
- GENERAL CONDITIONS OF CONTRACT (GCC)

Part One - Section I Instructions to Bidders

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Instructions to Bidders

A. Introduction

- 1. Source of Funds**
- 1.1 The Borrower named in the Bid Data Sheet has applied for or received a loan or Grant (hereinafter called “loan”) from the International Bank for Reconstruction and Development or from the International Development Association (as identified in the Bid Data Sheet and hereinafter interchangeably called “the Bank”) in various currencies equivalent to the U.S. dollar amount indicated in the Bid Data Sheet towards the cost of the Project specified in the Bid Data Sheet. The Borrower intends to apply a portion of the proceeds of this loan to eligible payments under the contract for which this Invitation for Bids is issued.
- 1.2 Payment by the Bank will be made only at the request of the Borrower and upon approval by the Bank in accordance with the terms and conditions of the Loan Agreement, and will be subject in all respects to the terms and conditions of that agreement. The Loan Agreement prohibits a withdrawal from the loan account for the purpose of any payment to persons or entities, or for any import of goods, if such payment or import, to the knowledge of the Bank, is prohibited by a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations. No party other than the Borrower shall derive any rights from the Loan Agreement or have any claim to the loan proceeds.
- 2. Eligible Bidders**
- 2.1 This Invitation for Bids is open to all suppliers from eligible source countries as defined in *Guidelines: Procurement under IBRD Loans and IDA Grants*, dated January 1995, hereinafter referred as the *IBRD Guidelines for Procurement*, except as provided hereinafter.
- 2.2 Bidders should not be associated, or have been associated in the past, directly or indirectly, with a firm or any of its affiliates which have been engaged by the Purchaser to provide consulting services for the preparation of the design, specifications, and other documents to be used for the procurement of the goods to be purchased under this Invitation for Bids.
- 2.3 Government-owned enterprises in the Purchaser’s country may participate only if they are legally and financially autonomous, if they operate under commercial law, and if they are not a dependent agency of the Purchaser.
- 2.4 Bidders shall not be under a declaration of ineligibility for corrupt and fraudulent practices issued by the Bank in accordance with sub-cause 34.1.

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- 3. Eligible Goods and Services**
- 3.1 All goods and related services to be supplied under the contract shall have their origin in eligible source countries, defined in the *IBRD Guidelines for Procurement*, and all expenditures made under the contract will be limited to such goods and services.
- 3.2 For purposes of this clause, “origin” means the place where the goods are mined, grown, or produced, or the place from which the related services are supplied. Goods are produced when, through manufacturing, processing, or substantial and major assembly of components, a commercially-recognized product results that is substantially different in basic characteristics or in purpose or utility from its components.
- 3.3 The origin of goods and services is distinct from the nationality of the Bidder.
- 4. Cost of Bidding**
- 4.1 The Bidder shall bear all costs associated with the preparation and submission of its bid, and the Purchaser named in the Bid Data Sheet, hereinafter referred to as “the Purchaser,” will in no case be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process.

B. The Bidding Documents

- 5. Content of Bidding Documents**
- 5.1 The goods required, bidding procedures, and contract terms are prescribed in the bidding documents. In addition to the Invitation for Bids, the bidding documents include:
- (a) Instructions to Bidders (ITB)
 - (b) Bid Data Sheet
 - (c) General Conditions of Contract (GCC)
 - (d) Special Conditions of Contract (SCC)
 - (e) Schedule of Requirements
 - (f) Technical Specifications
 - (g) Bid Form and Price Schedules
 - (h) Bid Security Form
 - (i) Contract Form
 - (j) Performance Security Form
 - (k) Bank Guarantee for Advance Payment Form
 - (l) Manufacturer’s Authorization Form
- 5.2 The Bidder is expected to examine all instructions, forms, terms, and specifications in the bidding documents. Failure to furnish all information required by the bidding documents or to submit a bid not substantially responsive to the bidding documents in every respect will be at the Bidder’s risk and may result in the rejection of its bid.

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| 6. Clarification of Bidding Documents | 6.1 A prospective Bidder requiring any clarification of the bidding documents may notify the Purchaser in writing or by cable (hereinafter, the term <i>cable</i> is deemed to include telex and facsimile) at the Purchaser's address indicated in ITB Clause 19.1. The Purchaser will respond in writing to any request for clarification of the bidding documents which it receives no later than twenty (20) days prior to the deadline for the submission of bids prescribed in the Bid Data Sheet. Written copies of the Purchaser's response (including an explanation of the query but without identifying the source of inquiry) will be sent to all prospective bidders that have received the bidding documents. |
| 7. Amendment of Bidding Documents | <p>7.1 At any time prior to the deadline for submission of bids, the Purchaser, for any reason, whether at its own initiative or in response to a clarification requested by a prospective Bidder, may modify the bidding documents by amendment.</p> <p>7.2 All prospective bidders that have received the bidding documents will be notified of the amendment in writing or by cable, and will be bidding on them.</p> <p>7.3 In order to allow prospective bidders reasonable time in which to take the amendment into account in preparing their bids, the Purchaser, at its discretion, may extend the deadline for the submission of bids.</p> |

C. Preparation of Bids

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| 8. Language of Bid | 8.1 The bid prepared by the Bidder, as well as all correspondence and documents relating to the bid exchanged by the Bidder and the Purchaser, shall be written in the language specified in the Bid Data Sheet. Supporting documents and printed literature furnished by the Bidder may be in another language provided they are accompanied by an accurate translation of the relevant passages in the language specified in the Bid Data Sheet, in which case, for purposes of interpretation of the Bid, the translation shall govern. |
| 9. Documents Comprising the Bid | <p>9.1 The bid prepared by the Bidder shall comprise the following components:</p> <ul style="list-style-type: none">(a) a Bid Form and a Price Schedule completed in accordance with ITB Clauses 10, 11, and 12;(b) documentary evidence established in accordance with ITB Clause 13 that the Bidder is eligible to bid and is qualified to perform the contract if its bid is accepted;(c) documentary evidence established in accordance with ITB |

Clause 14 that the goods and ancillary services to be supplied by the Bidder are eligible goods and services and conform to the bidding documents; and

(d) bid security furnished in accordance with ITB Clause 15.

10. Bid Form

10.1 The Bidder shall complete the Bid Form and the appropriate Price Schedule furnished in the bidding documents, indicating the goods to be supplied, a brief description of the goods, their country of origin, quantity, and prices.

11. Bid Prices

11.1 The Bidder shall indicate on the appropriate Price Schedule the unit prices (where applicable) and total bid price of the goods it proposes to supply under the contract.

11.2 Prices indicated on the Price Schedule shall be delivered duty paid (DDP) prices. The price of other (incidental) services, if any, listed in the Bid Data Sheet will be entered separately.

11.3 The term DDP (Delivered Duty Paid), shall be governed by the rules prescribed in the current edition of *Incoterms* published by the International Chamber of Commerce, Paris.

11.4 The Bidder's separation of price components in accordance with ITB Clause 11.2 above will be solely for the purpose of facilitating the comparison of bids by the Purchaser and will not in any way limit the Purchaser's right to contract on any of the terms offered.

11.5 Prices quoted by the Bidder shall be fixed during the Bidder's performance of the contract and not subject to variation on any account, unless otherwise specified in the Bid Data Sheet. A bid submitted with an adjustable price quotation will be treated as nonresponsive and will be rejected, pursuant to ITB Clause 24. If, however, in accordance with the Bid Data Sheet, prices quoted by the Bidder shall be subject to adjustment during the performance of the contract, a bid submitted with a fixed price quotation will not be rejected, but the price adjustment would be treated as zero.

12. Bid Currencies

12.1 Prices shall be quoted in Pak Rupees unless otherwise specified in the Bid Data Sheet.

**13. Documents
Establishing
Bidder's
Eligibility and
Qualification**

13.1 Pursuant to ITB Clause 9, the Bidder shall furnish, as part of its bid, documents establishing the Bidder's eligibility to bid and its qualifications to perform the contract if its bid is accepted.

13.2 The documentary evidence of the Bidder's eligibility to bid shall establish to the Purchaser's satisfaction that the Bidder, at the time of

submission of its bid, is from an eligible country as defined under ITB Clause 2.

13.3 The documentary evidence of the Bidder's qualifications to perform the contract if its bid is accepted shall establish to the Purchaser's satisfaction:

- (a) that, in the case of a Bidder offering to supply goods under the contract which the Bidder did not manufacture or otherwise produce, the Bidder has been duly authorized by the goods' Manufacturer or producer to supply the goods in the Purchaser's country;
- (b) that the Bidder has the financial, technical, and production capability necessary to perform the contract;
- (c) that, in the case of a Bidder not doing business within the Purchaser's country, the Bidder is or will be (if awarded the contract) represented by an Agent in that country equipped, and able to carry out the Supplier's maintenance, repair, and spare parts-stocking obligations prescribed in the Conditions of Contract and/or Technical Specifications; and
- (d) that the Bidder meets the qualification criteria listed in the Bid Data Sheet.

14. Documents
Establishing
Goods'
Eligibility and
Conformity to
Bidding
Documents

14.1 Pursuant to ITB Clause 9, the Bidder shall furnish, as part of its bid, documents establishing the eligibility and conformity to the bidding documents of all goods and services which the Bidder proposes to supply under the contract.

14.2 The documentary evidence of the eligibility of the goods and services shall consist of a statement in the Price Schedule of the country of origin of the goods and services offered which shall be confirmed by a certificate of origin issued at the time of shipment.

14.3 The documentary evidence of conformity of the goods and services to the bidding documents may be in the form of literature, drawings, and data, and shall consist of:

- (a) a detailed description of the essential technical and performance characteristics of the goods;
- (b) a list giving full particulars, including available sources and current prices of spare parts, special tools, etc., necessary for the proper and continuing functioning of the goods for a period to be specified in the Bid Data Sheet, following commencement of the

use of the goods by the Purchaser; and

- (c) an item-by-item commentary on the Purchaser's Technical Specifications demonstrating substantial responsiveness of the goods and services to those specifications, or a statement of deviations and exceptions to the provisions of the Technical Specifications.

14.4 For purposes of the commentary to be furnished pursuant to ITB Clause 14.3(c) above, the Bidder shall note that standards for workmanship, material, and equipment, as well as references to brand names or catalogue numbers designated by the Purchaser in its Technical Specifications, are intended to be descriptive only and not restrictive. The Bidder may substitute alternative standards, brand names, and/or catalogue numbers in its bid, provided that it demonstrates to the Purchaser's satisfaction that the substitutions ensure substantial equivalence to those designated in the Technical Specifications.

15. Bid Security

15.1 Pursuant to ITB Clause 9, the Bidder shall furnish, as part of its bid, a bid security in the amount specified in the Bid Data Sheet.

15.2 The bid security is required to protect the Purchaser against the risk of Bidder's conduct which would warrant the security's forfeiture, pursuant to ITB Clause 15.7.

15.3 The bid security shall be in Pak. Rupees and shall be in one of the following forms:

- (a) a bank guarantee or an irrevocable letter of Grant issued by a reputable bank located in the Purchaser's country, in the form provided in the bidding documents or another form acceptable to the Purchaser and valid for thirty (30) days beyond the validity of the bid; or
- (b) a cashier's or certified check.
- (c) irrevocable cashable on-demand Bank call-deposit.

15.4 Any bid not secured in accordance with ITB Clauses 15.1 and 15.3 will be rejected by the Purchaser as nonresponsive, pursuant to ITB Clause 24.

15.5 Unsuccessful bidders' bid security will be discharged or returned as promptly as possible but not later than thirty (30) days after the expiration of the period of bid validity prescribed by the Purchaser pursuant to ITB Clause 16.

15.6 The successful Bidder's bid security will be discharged upon the

Bidder signing the contract, pursuant to ITB Clause 32, and furnishing the performance security, pursuant to ITB Clause 33.

15.7 The bid security may be forfeited:

- (a) if a Bidder withdraws its bid during the period of bid validity specified by the Bidder on the Bid Form; or
- (b) in the case of a successful Bidder, if the Bidder fails:
 - (i) to sign the contract in accordance with ITB Clause 32;
 - or**
 - (ii) to furnish performance security in accordance with ITB Clause 33.

**16. Period of
Validity of Bids**

- 16.1 Bids shall remain valid for the period specified in the Bid Data Sheet after the date of bid opening prescribed by the Purchaser, pursuant to ITB Clause 19. A bid valid for a shorter period shall be rejected by the Purchaser as nonresponsive.
- 16.2 In exceptional circumstances, the Purchaser may solicit the Bidder's consent to an extension of the period of validity. The request and the responses thereto shall be made in writing (or by cable). The bid security provided under ITB Clause 15 shall also be suitably extended. A Bidder may refuse the request without forfeiting its bid security. A Bidder granting the request will not be required nor permitted to modify its bid, except as provided in ITB Clause 16.3.
- 16.3 In the case of fixed price contracts, if the award is delayed by a period exceeding sixty (60) days beyond the expiry of the initial bid validity, the contract price will be adjusted by a factor specified in the request for extension.

**17. Format and
Signing of Bid**

- 17.1 The Bidder shall prepare an original and the number of copies of the bid indicated in the Bid Data Sheet, clearly marking each "ORIGINAL BID" and "COPY OF BID," as appropriate. In the event of any discrepancy between them, the original shall govern.
- 17.2 The original and the copy or copies of the bid shall be typed or written in indelible ink and shall be signed by the Bidder or a person or persons duly authorized to bind the Bidder to the contract. All pages of the bid, except for unamended printed literature, shall be initialed by the person or persons signing the bid.
- 17.3 Any interlineation, erasures, or overwriting shall be valid only if they are initialed by the person or persons signing the bid.

- 17.4 The Bidder shall furnish information as described in the Form of Bid on commissions or gratuities, if any, paid or to be paid to agents relating to this Bid, and to contract execution if the Bidder is awarded the contract.

D. Submission of Bids

18. Sealing and Marking of Bids

- 18.1 The Bidder shall seal the original and each copy of the bid in separate envelopes, duly marking the envelopes as “ORIGINAL” and “COPY.” The envelopes shall then be sealed in an outer envelope.
- 18.2 The inner and outer envelopes shall:
- (a) be addressed to the Purchaser at the address given in the Bid Data Sheet; and
 - (b) bear the Project name indicated in the Bid Data Sheet, the Invitation for Bids (IFB) title and number indicated in the Bid Data Sheet, and a statement: “DO NOT OPEN BEFORE,” to be completed with the time and the date specified in the Bid Data Sheet, pursuant to ITB Clause 2.2.
- 18.3 The inner envelopes shall also indicate the name and address of the Bidder to enable the bid to be returned unopened in case it is declared “late”.
- 18.4 If the outer envelope is not sealed and marked as required by ITB Clause 18.2, the Purchaser will assume no responsibility for the bid’s misplacement or premature opening.

19. Deadline for Submission of Bids

- 19.1 Bids must be received by the Purchaser at the address specified under ITB Clause 18.2 no later than the time and date specified in the Bid Data Sheet.
- 19.2 The Purchaser may, at its discretion, extend this deadline for the submission of bids by amending the bidding documents in accordance with ITB Clause 7, in which case all rights and obligations of the Purchaser and bidders previously subject to the deadline will thereafter be subject to the deadline as extended.

20. Late Bids

- 20.1 Any bid received by the Purchaser after the deadline for submission of bids prescribed by the Purchaser pursuant to ITB Clause 19 will be rejected and returned unopened to the Bidder.

21. Modification and Withdrawal of Bids

- 21.1 The Bidder may modify or withdraw its bid after the bid’s submission, provided that written notice of the modification, including substitution or withdrawal of the bids, is received by the Purchaser prior to the

deadline prescribed for submission of bids.

21.2 The Bidder's modification or withdrawal notice shall be prepared, sealed, marked, and dispatched in accordance with the provisions of ITB Clause 18. A withdrawal notice may also be sent by cable, but followed by a signed confirmation copy, postmarked no later than the deadline for submission of bids.

21.3 No bid may be modified after the deadline for submission of bids.

21.4 No bid may be withdrawn in the interval between the deadline for submission of bids and the expiration of the period of bid validity specified by the Bidder on the Bid Form. Withdrawal of a bid during this interval may result in the Bidder's forfeiture of its bid security, pursuant to the ITB Clause 15.7.

E. Opening and Evaluation of Bids

22. Opening of Bids by the Purchaser

22.1 The Purchaser will open all bids in the presence of bidders' representatives who choose to attend, at the time, on the date, and at the place specified in the Bid Data Sheet. The bidders' representatives who are present shall sign a register evidencing their attendance.

22.2 The bidders' names, bid modifications or withdrawals, bid prices, discounts, and the presence or absence of requisite bid security and such other details as the Purchaser, at its discretion, may consider appropriate, will be announced at the opening. No bid shall be rejected at bid opening, except for late bids, which shall be returned unopened to the Bidder pursuant to ITB Clause 20.

22.3 Bids (and modifications sent pursuant to ITB Clause 21.2) that are not opened and read out at bid opening shall not be considered further for evaluation, irrespective of the circumstances. Withdrawn bids will be returned unopened to the bidders.

22.4 The Purchaser will prepare minutes of the bid opening.

23. Clarification of Bids

23.1 During evaluation of the bids, the Purchaser may, at its discretion, ask the Bidder for a clarification of its bid. The request for clarification and the response shall be in writing, and no change in the prices or substance of the bid shall be sought, offered, or permitted.

24. Preliminary Examination

24.1 The Purchaser will examine the bids to determine whether they are complete, whether any computational errors have been made, whether required sureties have been furnished, whether the documents have been properly signed, and whether the bids are generally in order.

- 24.2 Arithmetical errors will be rectified on the following basis. If there is a discrepancy between the unit price and the total price that is obtained by multiplying the unit price and quantity, the unit price shall prevail, and the total price shall be corrected. If the Supplier does not accept the correction of the errors, its bid will be rejected, and its bid security may be forfeited. If there is a discrepancy between words and figures, the amount in words will prevail.
- 24.3 The Purchaser may waive any minor informality, nonconformity, or irregularity in a bid which does not constitute a material deviation, provided such waiver does not prejudice or affect the relative ranking of any Bidder.
- 24.4 Prior to the detailed evaluation, pursuant to ITB Clause 25 the Purchaser will determine the substantial responsiveness of each bid to the bidding documents. For purposes of these Clauses, a substantially responsive bid is one which conforms to all the terms and conditions of the bidding documents without material deviations. Deviations from, or objections or reservations to critical provisions, **such as** those concerning Bid Security (ITB Clause 15), Applicable Law (GCC Clause 30), and Taxes and Duties (GCC Clause 32), will be deemed to be a material deviation. The Purchaser's determination of a bid's responsiveness is to be based on the contents of the bid itself without recourse to extrinsic evidence.
- 24.5 If a bid is not substantially responsive, it will be rejected by the Purchaser and may not subsequently be made responsive by the Bidder by correction of the nonconformity.

**25. Evaluation and
Comparison of
Bids**

- 25.1 The Purchaser will evaluate and compare the bids which have been determined to be substantially responsive, pursuant to ITB Clause 24.
- 25.2 The Purchaser's evaluation of a bid will be on delivered duty paid (DDP) price inclusive of prevailing duties and will exclude any allowance for price adjustment during the period of execution of the contract, if provided in the bid.
- 25.3 The Purchaser's evaluation of a bid will take into account, in addition to the bid price quoted in accordance with ITB Clause 11.2, one or more of the following factors as specified in the Bid Data Sheet, and quantified in ITB Clause 25.4:
- (a) incidental costs
 - (b) delivery schedule offered in the bid;
 - (c) deviations in payment schedule from that specified in the Special

Conditions of Contract;

- (d) the cost of components, mandatory spare parts, and service;
- (e) the availability in the Purchaser's country of spare parts and after-sales services for the equipment offered in the bid;
- (f) the projected operating and maintenance costs during the life of the equipment;
- (g) the performance and productivity of the equipment offered; and/or
- (h) other specific criteria indicated in the Bid Data Sheet and/or in the Technical Specifications.

25.4 For factors retained in the Bid Data Sheet pursuant to ITB 25.3, one or more of the following quantification methods will be applied, as detailed in the Bid Data Sheet:

- (a) Incidental costs provided by the bidder will be added by Purchaser to the delivered duty paid (DDP) price at the final destination.
- (b) *Delivery schedule.*
 - (i) The Purchaser requires that the goods under the Invitation for Bids shall be delivered at the time specified in the Schedule of Requirements which will be treated as the base, a delivery "adjustment" will be calculated for bids by applying a percentage, specified in the Bid Data Sheet, of the DDP price for each week of delay beyond the base, and this will be added to the bid price for evaluation. No Grant shall be given to early delivery.
 - or**
 - (ii) The goods covered under this invitation are required to be delivered (shipped) within an acceptable range of weeks specified in the Schedule of Requirement. No Grant will be given to earlier deliveries, and bids offering delivery beyond this range will be treated as nonresponsive. Within this acceptable range, an adjustment per week, as specified in the Bid Data Sheet, will be added for evaluation to the bid price of bids offering deliveries later than the earliest delivery period specified in the Schedule of Requirements.
 - or**
 - (iii) The goods covered under this invitation are required to be delivered in partial shipments, as specified in the Schedule of Requirements. Bids offering deliveries earlier or later

than the specified deliveries will be adjusted in the evaluation by adding to the bid price a factor equal to a percentage, specified in the Bid Data Sheet, of DDP price per week of variation from the specified delivery schedule.

(c) *Deviation in payment schedule.*

- (i) Bidders shall state their bid price for the payment schedule outlined in the SCC. Bids will be evaluated on the basis of this base price. Bidders are, however, permitted to state an alternative payment schedule and indicate the reduction in bid price they wish to offer for such alternative payment schedule. The Purchaser may consider the alternative payment schedule offered by the selected Bidder.

or

- (ii) The SCC stipulate the payment schedule offered by the Purchaser. If a bid deviates from the schedule and if such deviation is considered acceptable to the Purchaser, the bid will be evaluated by calculating interest earned for any earlier payments involved in the terms outlined in the bid as compared with those stipulated in this invitation, at the rate per annum specified in the Bid Data Sheet.

(d) *Cost of spare parts.*

- (i) The list of items and quantities of major assemblies, components, and selected spare parts, likely to be required during the initial period of operation specified in the Bid Data Sheet, is annexed to the Technical Specifications. The total cost of these items, at the unit prices quoted in each bid, will be added to the bid price.

or

- (ii) The Purchaser will draw up a list of high-usage and high-value items of components and spare parts, along with estimated quantities of usage in the initial period of operation specified in the Bid Data Sheet. The total cost of these items and quantities will be computed from spare parts unit prices submitted by the Bidder and added to the bid price.

or

- (iii) The Purchaser will estimate the cost of spare parts usage in the initial period of operation specified in the Bid Data Sheet, based on information furnished by each Bidder, as well as on past experience of the Purchaser or other purchasers in similar situations. Such costs shall be added to the bid price for evaluation.

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- (e) *Spare parts and after sales service facilities in the Purchaser's country.*

The cost to the Purchaser of establishing the minimum service facilities and parts inventories, as outlined in the Bid Data Sheet or elsewhere in the bidding documents, if quoted separately, shall be added to the bid price.

- (f) *Operating and maintenance costs.*

Since the operating and maintenance costs of the goods under procurement form a major part of the life cycle cost of the equipment, these costs will be evaluated in accordance with the criteria specified in the Bid Data Sheet or in the Technical Specifications.

- (g) *Performance and productivity of the equipment.*

(i) Bidders shall state the guaranteed performance or efficiency in response to the Technical Specification. For each drop in the performance or efficiency below the norm of 100, an adjustment for an amount specified in the Bid Data Sheet will be added to the bid price, representing the capitalized cost of additional operating costs over the life of the plant, using the methodology specified in the Bid Data Sheet or in the Technical Specifications.

or

(ii) Goods offered shall have a minimum productivity specified under the relevant provision in the Technical Specifications to be considered responsive. Evaluation shall be based on the cost per unit of the actual productivity of goods offered in the bid, and adjustment will be added to the bid price using the methodology specified in the Bid Data Sheet or in the Technical Specifications.

- (h) *Specific additional criteria indicated in the Bid Data Sheet and/or in the Technical Specifications.*

The relevant evaluation method shall be detailed in the Bid Data Sheet and/or in the Technical Specifications.

Alternative

25.4 Merit Point System:

The following merit point system for weighing evaluation factors can be applied if none of the evaluation methods listed in 25.4 above has

been retained in the Bid Data Sheet. The number of points allocated to each factor shall be specified in the Bid Data Sheet.

Evaluated price of the goods	60 to 90
Cost of common list spare parts	0 to 20
Technical features, and maintenance and operating costs	0 to 20
Availability of service and spare parts	0 to 20
Standardization	0 to 20
Total	100

The bid scoring the highest number of points will be deemed to be the lowest evaluated bid.

26. Contacting the Purchaser

- 26.1 Subject to ITB Clause 23, no Bidder shall contact the Purchaser on any matter relating to its bid, from the time of the bid opening to the time the contract is awarded. If the Bidder wishes to bring additional information to the notice of the Purchaser, it should do so in writing.
- 26.2 Any effort by a Bidder to influence the Purchaser in its decisions on bid evaluation, bid comparison, or contract award may result in the rejection of the Bidder's bid.

F. Award of Contract

27. Post-qualification

- 27.1 In the absence of prequalification, the Purchaser will determine to its satisfaction whether the Bidder that is selected as having submitted the lowest evaluated responsive bid is qualified to perform the contract satisfactorily, in accordance with the criteria listed in ITB Clause 13.3.
- 27.2 The determination will take into account the Bidder's financial, technical, and production capabilities. It will be based upon an examination of the documentary evidence of the Bidder's qualifications submitted by the Bidder, pursuant to ITB Clause 13.3, as well as such other information as the Purchaser deems necessary and appropriate.
- 27.3 An affirmative determination will be a prerequisite for award of the contract to the Bidder. A negative determination will result in rejection of the Bidder's bid, in which event the Purchaser will proceed to the next lowest evaluated bid to make a similar determination of that Bidder's capabilities to perform satisfactorily.

28. Award Criteria

- 28.1 Subject to ITB Clause 30, the Purchaser will award the contract to the successful Bidder whose bid has been determined to be substantially responsive and has been determined to be the lowest evaluated bid, provided further that the Bidder is determined to be qualified to perform the contract satisfactorily.

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| 29. Purchaser's
Right to Vary
Quantities at
Time of Award | 29.1 The Purchaser reserves the right at the time of contract award to increase or decrease, by the percentage indicated in the Bid Data Sheet, the quantity of goods and services originally specified in the Schedule of Requirements without any change in unit price or other terms and conditions. |
| 30. Purchaser's
Right to Accept
any Bid and to
Reject any or
All Bids | 30.1 The Purchaser reserves the right to accept or reject any bid, and to annul the bidding process and reject all bids at any time prior to contract award, without thereby incurring any liability to the affected Bidder or bidders or any obligation to inform the affected Bidder or bidders of the grounds for the Purchaser's action. |
| 31. Notification of
Award | <p>31.1 Prior to the expiration of the period of bid validity, the Purchaser will notify the successful Bidder in writing by registered letter or by cable, to be confirmed in writing by registered letter, that its bid has been accepted.</p> <p>31.2 The notification of award will constitute the formation of the Contract.</p> <p>31.3 Upon the successful Bidder's furnishing of the performance security pursuant to ITB Clause 33, the Purchaser will promptly notify each unsuccessful Bidder and will discharge its bid security, pursuant to ITB Clause 15.</p> |
| 32. Signing of
Contract | <p>32.1 At the same time as the Purchaser notifies the successful Bidder that its bid has been accepted, the Purchaser will send the Bidder the Contract Form provided in the bidding documents, incorporating all agreements between the parties.</p> <p>32.2 Within thirty (30) days of receipt of the Contract Form, the successful Bidder shall sign and date the contract and return it to the Purchaser.</p> |
| 33 Performance
Security | <p>33.1 Within twenty (20) days of the receipt of notification of award from the Purchaser, the successful Bidder shall furnish the performance security in accordance with the Conditions of Contract, in the Performance Security Form provided in the bidding documents, or in another form acceptable to the Purchaser.</p> <p>33.2 Failure of the successful Bidder to comply with the requirement of ITB Clause 32 or ITB Clause 33.1 shall constitute sufficient grounds for the annulment of the award and forfeiture of the bid security, in which event the Purchaser may make the award to the next lowest evaluated Bidder or call for new bids.</p> |
| 34. Corrupt or
Fraudulent
Practices | 34.1 The Bank requires that Borrowers (including beneficiaries of Bank loans), as well as Bidders/Suppliers/Contractors under Bank-financed contracts, observe the highest standard of ethics during the procurement and execution of such contracts. In pursuance of this |
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policy, the Bank:

- (a) defines, for the purposes of this provision, the terms set forth below as follows:
 - (i) “corrupt practice” means the offering, giving, receiving or soliciting of anything of value to influence the action of a public official in the procurement process or in contract execution; and
 - (ii) “fraudulent practice” means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Borrower, and includes collusive practice among Bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Borrower of the benefits of free and open competition;
- (b) will reject a proposal for award if it determines that the Bidder recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question;
- (c) will declare a firm ineligible, either indefinitely or for a stated period of time, to be awarded a Bank-financed contract if it at any time determines that the firm has engaged in corrupt or fraudulent practices in competing for, or in executing, a Bank-financed contract.

34.2 Furthermore, Bidders shall be aware of the provision stated in sub-clause 5.4 and sub-clause 24.1 of the General Conditions of Contract.

Part One - Section II General Conditions of Contract

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General Conditions of Contract

1. Definitions

1.1 In this Contract, the following terms shall be interpreted as indicated:

- (a) “The Contract” means the agreement entered into between the Purchaser and the Supplier, as recorded in the Contract Form signed by the parties, including all attachments and appendices thereto and all documents incorporated by reference therein.
- (b) “The Contract Price” means the price payable to the Supplier under the Contract for the full and proper performance of its contractual obligations.
- (c) “The Goods” means all of the equipment, machinery, and/or other materials which the Supplier is required to supply to the Purchaser under the Contract.
- (d) “The Services” means those services ancillary to the supply of the Goods, such as transportation and insurance, and any other incidental services, such as installation, commissioning, provision of technical assistance, training, and other such obligations of the Supplier covered under the Contract.
- (e) “GCC” means the General Conditions of Contract contained in this section.
- (f) “SCC” means the Special Conditions of Contract.
- (g) “The Purchaser” means the organization purchasing the Goods, as named in SCC.
- (h) “The Purchaser’s country” is the country named in SCC.
- (i) “The Supplier” means the individual or firm supplying the Goods and Services under this Contract.
- (j) “The World Bank” means the International Bank for Reconstruction and Development (IBRD) or the International Development Association (IDA).
- (k) “The Project Site,” where applicable, means the place or places named in SCC.
- (l) “Day” means calendar day.

2. Application

2.1 These General Conditions shall apply to the extent that they are not superseded by provisions of other parts of the Contract.

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| 3. Country of Origin | <p>3.1 All Goods and Services supplied under the Contract shall have their origin in the countries and territories eligible under the rules of the World Bank, as further elaborated in the SCC.</p> <p>3.2 For purposes of this Clause, “origin” means the place where the Goods were mined, grown, or produced, or from which the Services are supplied. Goods are produced when, through manufacturing, processing, or substantial and major assembly of components, a commercially recognized new product results that is substantially different in basic characteristics or in purpose or utility from its components.</p> <p>3.3 The origin of Goods and Services is distinct from the nationality of the Supplier.</p> |
| 4. Standards | <p>4.1 The Goods supplied under this Contract shall conform to the standards mentioned in the Technical Specifications, and, when no applicable standard is mentioned, to the authoritative standards appropriate to the Goods’ country of origin. Such standards shall be the latest issued by the concerned institution.</p> |
| 5. Use of Contract Documents and Information; Inspection and Audit by the Bank | <p>5.1 The Supplier shall not, without the Purchaser’s prior written consent, disclose the Contract, or any provision thereof, or any specification, plan, drawing, pattern, sample, or information furnished by or on behalf of the Purchaser in connection therewith, to any person other than a person employed by the Supplier in the performance of the Contract. Disclosure to any such employed person shall be made in confidence and shall extend only so far as may be necessary for purposes of such performance.</p> <p>5.2 The Supplier shall not, without the Purchaser’s prior written consent, make use of any document or information enumerated in GCC Clause 5.1 except for purposes of performing the Contract.</p> <p>5.3 Any document, other than the Contract itself, enumerated in GCC Clause 5.1 shall remain the property of the Purchaser and shall be returned (all copies) to the Purchaser on completion of the Supplier’s performance under the Contract if so required by the Purchaser.</p> <p>5.4 The Supplier shall permit the Bank to inspect the Supplier’s accounts and records relating to the performance of the Supplier and to have them audited by auditors appointed by the Bank, if so required by the Bank.</p> |
| 6. Patent Rights | <p>6.1 The Supplier shall indemnify the Purchaser against all third-party</p> |

claims of infringement of patent, trademark, or industrial design rights arising from use of the Goods or any part thereof in the Purchaser's country.

7. Performance Security

7.1 Within twenty (20) days of receipt of the notification of Contract award, the successful Bidder shall furnish to the Purchaser the performance security in the amount specified in SCC.

7.2 The proceeds of the performance security shall be payable to the Purchaser as compensation for any loss resulting from the Supplier's failure to complete its obligations under the Contract.

7.3 The performance security shall be denominated in the currency of the Contract acceptable to the Purchaser and shall be in one of the following forms:

(a) a bank guarantee or an irrevocable letter of Grant issued by a reputable bank located in the Purchaser's country, in the form provided in the bidding documents or another form acceptable to the Purchaser; or

(b) a cashier's or certified check.

7.4 The performance security will be discharged by the Purchaser and returned to the Supplier not later than thirty (30) days following the date of completion of the Supplier's performance obligations under the Contract, including any warranty obligations, unless specified otherwise in SCC.

8. Inspections and Tests

8.1 The Purchaser or its representative shall have the right to inspect and/or to test the Goods to confirm their conformity to the Contract specifications at no extra cost to the Purchaser. SCC and the Technical Specifications shall specify what inspections and tests the Purchaser requires and where they are to be conducted. The Purchaser shall notify the Supplier in writing, in a timely manner, of the identity of any representatives retained for these purposes.

8.2 The inspections and tests may be conducted on the premises of the Supplier or its subcontractor(s), at point of delivery, and/or at the Goods' final destination. If conducted on the premises of the Supplier or its subcontractor(s), all reasonable facilities and assistance, including access to drawings and production data, shall be furnished to the inspectors at no charge to the Purchaser.

8.3 Should any inspected or tested Goods fail to conform to the Specifications, the Purchaser may reject the Goods, and the Supplier shall either replace the rejected Goods or make alterations necessary to

meet specification requirements free of cost to the Purchaser.

- 8.4 The Purchaser's right to inspect, test and, where necessary, reject the Goods after the Goods' arrival in the Purchaser's country shall in no way be limited or waived by reason of the Goods having previously been inspected, tested, and passed by the Purchaser or its representative prior to the Goods' shipment from the country of origin.
- 8.5 Nothing in GCC Clause 8 shall in any way release the Supplier from any warranty or other obligations under this Contract.

9. Packing

- 9.1 The Supplier shall provide such packing of the Goods as is required to prevent their damage or deterioration during transit to their final destination, as indicated in the Contract. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit, and open storage. Packing case size and weights shall take into consideration, where appropriate, the remoteness of the Goods' final destination and the absence of heavy handling facilities at all points in transit.
- 9.2 The packing, marking, and documentation within and outside the packages shall comply strictly with such special requirements as shall be expressly provided for in the Contract, including additional requirements, if any, specified in SCC, and in any subsequent instructions ordered by the Purchaser.

10. Delivery and Documents

- 10.1 Delivery of the Goods shall be made by the Supplier in accordance with the terms specified in the Schedule of Requirements. The details of shipping and/or other documents to be furnished by the Supplier are specified in SCC.
- 10.2 For purposes of the Contract, DDP trade term used to describe the obligations of the parties shall have the meanings assigned to them by the current edition of *Incoterms* published by the International Chamber of Commerce, Paris.
- 10.3 Documents to be submitted by the Supplier are specified in SCC.

11. Insurance

- 11.1 The Goods supplied under the Contract shall be delivered duty paid (DDP) under which risk is transferred to the buyer after having been delivered, hence insurance coverage is sellers' responsibility.

12. Transportation

- 12.1 The Supplier is required under the Contract to transport the Goods to a specified place of destination within the Purchaser's country, transport to such place of destination in the Purchaser's country, including insurance and storage, as shall be specified in the Contract, shall be

arranged by the Supplier, and related costs shall be included in the Contract Price.

13. Incidental Services

13.1 The Supplier may be required to provide any or all of the following services, including additional services, if any, specified in SCC:

- (a) performance or supervision of on-site assembly and/or start-up of the supplied Goods;
- (b) furnishing of tools required for assembly and/or maintenance of the supplied Goods;
- (c) furnishing of a detailed operations and maintenance manual for each appropriate unit of the supplied Goods;
- (d) performance or supervision or maintenance and/or repair of the supplied Goods, for a period of time agreed by the parties, provided that this service shall not relieve the Supplier of any warranty obligations under this Contract; and
- (e) training of the Purchaser's personnel, at the Supplier's plant and/or on-site, in assembly, start-up, operation, maintenance, and/or repair of the supplied Goods.

13.2 Prices charged by the Supplier for incidental services, if not included in the Contract Price for the Goods, shall be agreed upon in advance by the parties and shall not exceed the prevailing rates charged for other parties by the Supplier for similar services.

14. Spare Parts

14.1 As specified in SCC, the Supplier may be required to provide any or all of the following materials, notifications, and information pertaining to spare parts manufactured or distributed by the Supplier:

- (a) such spare parts as the Purchaser may elect to purchase from the Supplier, provided that this election shall not relieve the Supplier of any warranty obligations under the Contract; and
- (b) in the event of termination of production of the spare parts:
 - (i) advance notification to the Purchaser of the pending termination, in sufficient time to permit the Purchaser to procure needed requirements; and
 - (ii) following such termination, furnishing at no cost to the Purchaser, the blueprints, drawings, and specifications of the spare parts, if requested.

15. Warranty

15.1 The Supplier warrants that the Goods supplied under the Contract are

new, unused, of the most recent or current models, and that they incorporate all recent improvements in design and materials unless provided otherwise in the Contract. The Supplier further warrants that all Goods supplied under this Contract shall have no defect, arising from design, materials, or workmanship (except when the design and/or material is required by the Purchaser's specifications) or from any act or omission of the Supplier, that may develop under normal use of the supplied Goods in the conditions prevailing in the country of final destination.

15.2 This warranty shall remain valid for twelve (12) months after the Goods, or any portion thereof as the case may be, have been delivered to and accepted at the final destination indicated in the Contract, or for eighteen (18) months after the date of shipment from the port or place of loading in the source country, whichever period concludes earlier, unless specified otherwise in SCC.

15.3 The Purchaser shall promptly notify the Supplier in writing of any claims arising under this warranty.

15.4 Upon receipt of such notice, the Supplier shall, within the period specified in SCC and with all reasonable speed, repair or replace the defective Goods or parts thereof, without costs to the Purchaser.

15.5 If the Supplier, having been notified, fails to remedy the defect(s) within the period specified in SCC, within a reasonable period, the Purchaser may proceed to take such remedial action as may be necessary, at the Supplier's risk and expense and without prejudice to any other rights which the Purchaser may have against the Supplier under the Contract.

16. Payment

16.1 The method and conditions of payment to be made to the Supplier under this Contract shall be specified in SCC.

16.2 The Supplier's request(s) for payment shall be made to the Purchaser in writing, accompanied by an invoice describing, as appropriate, the Goods delivered and Services performed, and by documents submitted pursuant to GCC Clause 10, and upon fulfillment of other obligations stipulated in the Contract.

16.3 Payments shall be made promptly by the Purchaser, but in no case later than sixty (60) days after submission of an invoice or claim by the Supplier.

16.4 The currency of payment is Pak. Rupees.

17. Prices

17.1 Prices charged by the Supplier for Goods delivered and Services

performed under the Contract shall not vary from the prices quoted by the Supplier in its bid, with the exception of any price adjustments authorized in SCC or in the Purchaser's request for bid validity extension, as the case may be.

18. Change Orders

18.1 The Purchaser may at any time, by a written order given to the Supplier pursuant to GCC Clause 31, make changes within the general scope of the Contract in any one or more of the following:

- (a) drawings, designs, or specifications, where Goods to be furnished under the Contract are to be specifically manufactured for the Purchaser;
- (b) the method of shipment or packing;
- (c) the place of delivery; and/or
- (d) the Services to be provided by the Supplier.

18.2 If any such change causes an increase or decrease in the cost of, or the time required for, the Supplier's performance of any provisions under the Contract, an equitable adjustment shall be made in the Contract Price or delivery schedule, or both, and the Contract shall accordingly be amended. Any claims by the Supplier for adjustment under this clause must be asserted within thirty (30) days from the date of the Supplier's receipt of the Purchaser's change order.

**19. Contract
Amendments**

19.1 Subject to GCC Clause 18, no variation in or modification of the terms of the Contract shall be made except by written amendment signed by the parties.

20. Assignment

20.1 The Supplier shall not assign, in whole or in part, its obligations to perform under this Contract, except with the Purchaser's prior written consent.

21. Subcontracts

21.1 The Supplier shall notify the Purchaser in writing of all subcontracts awarded under this Contract if not already specified in the bid. Such notification, in the original bid or later, shall not relieve the Supplier from any liability or obligation under the Contract.

21.2 Subcontracts must comply with the provisions of GCC Clause 3.

**22. Delays in the
Supplier's
Performance**

22.1 Delivery of the Goods and performance of Services shall be made by the Supplier in accordance with the time schedule prescribed by the Purchaser in the Schedule of Requirements.

22.2 If at any time during performance of the Contract, the Supplier or its

subcontractor(s) should encounter conditions impeding timely delivery of the Goods and performance of Services, the Supplier shall promptly notify the Purchaser in writing of the fact of the delay, its likely duration and its cause(s). As soon as practicable after receipt of the Supplier's notice, the Purchaser shall evaluate the situation and may at its discretion extend the Supplier's time for performance, with or without liquidated damages, in which case the extension shall be ratified by the parties by amendment of Contract.

22.3 Except as provided under GCC Clause 25, a delay by the Supplier in the performance of its delivery obligations shall render the Supplier liable to the imposition of liquidated damages pursuant to GCC Clause 23, unless an extension of time is agreed upon pursuant to GCC Clause 22.2 without the application of liquidated damages.

**23. Liquidated
Damages**

23.1 Subject to GCC Clause 25, if the Supplier fails to deliver any or all of the Goods or to perform the Services within the period(s) specified in the Contract, the Purchaser shall, without prejudice to its other remedies under the Contract, deduct from the Contract Price, as liquidated damages, a sum equivalent to the percentage specified in SCC of the delivered price of the delayed Goods or unperformed Services for each week or part thereof of delay until actual delivery or performance, up to a maximum deduction of the percentage specified in SCC. Once the maximum is reached, the Purchaser may consider termination of the Contract pursuant to GCC Clause 24.

**24. Termination for
Default**

24.1 The Purchaser, without prejudice to any other remedy for breach of Contract, by written notice of default sent to the Supplier, may terminate this Contract in whole or in part:

- (a) if the Supplier fails to deliver any or all of the Goods within the period(s) specified in the Contract, or within any extension thereof granted by the Purchaser pursuant to GCC Clause 22; or
- (b) if the Supplier fails to perform any other obligation(s) under the Contract.
- (c) if the Supplier, in the judgment of the Purchaser has engaged in corrupt or fraudulent practices in competing for or in executing the Contract.

For the purpose of this clause:

“corrupt practice” means the offering, giving, receiving or soliciting of anything of value to influence the action of a public official in the procurement process or in contract execution.

“fraudulent practice” means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Borrower, and includes collusive practice among Bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Borrower of the benefits of free and open competition.

24.2 In the event the Purchaser terminates the Contract in whole or in part, pursuant to GCC Clause 24.1, the Purchaser may procure, upon such terms and in such manner as it deems appropriate, Goods or Services similar to those undelivered, and the Supplier shall be liable to the Purchaser for any excess costs for such similar Goods or Services. However, the Supplier shall continue performance of the Contract to the extent not terminated.

25. Force Majeure

25.1 Notwithstanding the provisions of GCC Clauses 22, 23, and 24, the Supplier shall not be liable for forfeiture of its performance security, liquidated damages, or termination for default if and to the extent that its delay in performance or other failure to perform its obligations under the Contract is the result of an event of Force Majeure.

25.2 For purposes of this clause, “Force Majeure” means an event beyond the control of the Supplier and not involving the Supplier’s fault or negligence and not foreseeable. Such events may include, but are not restricted to, acts of the Purchaser in its sovereign capacity, wars or revolutions, fires, floods, epidemics, quarantine restrictions, and freight embargoes.

25.3 If a Force Majeure situation arises, the Supplier shall promptly notify the Purchaser in writing of such condition and the cause thereof. Unless otherwise directed by the Purchaser in writing, the Supplier shall continue to perform its obligations under the Contract as far as is reasonably practical, and shall seek all reasonable alternative means for performance not prevented by the Force Majeure event.

**26. Termination for
Insolvency**

26.1 The Purchaser may at any time terminate the Contract by giving written notice to the Supplier if the Supplier becomes bankrupt or otherwise insolvent. In this event, termination will be without compensation to the Supplier, provided that such termination will not prejudice or affect any right of action or remedy which has accrued or will accrue thereafter to the Purchaser.

**27. Termination for
Convenience**

27.1 The Purchaser, by written notice sent to the Supplier, may terminate the Contract, in whole or in part, at any time for its convenience. The notice of termination shall specify that termination is for the Purchaser’s convenience, the extent to which performance of the

Supplier under the Contract is terminated, and the date upon which such termination becomes effective.

27.2 The Goods that are complete and ready for shipment within thirty (30) days after the Supplier's receipt of notice of termination shall be accepted by the Purchaser at the Contract terms and prices. For the remaining Goods, the Purchaser may elect:

- (a) to have any portion completed and delivered at the Contract terms and prices; and/or
- (b) to cancel the remainder and pay to the Supplier an agreed amount for partially completed Goods and Services and for materials and parts previously procured by the Supplier.

28. Resolution of Disputes

28.1 The Purchaser and the Supplier shall make every effort to resolve amicably by direct informal negotiation any disagreement or dispute arising between them under or in connection with the Contract.

28.2 If, after thirty (30) days from the commencement of such informal negotiations, the Purchaser and the Supplier have been unable to resolve amicably a Contract dispute, either party may require that the dispute be referred for resolution to the formal mechanisms specified in SCC. These mechanisms may include, but are not restricted to, conciliation mediated by a third party, adjudication in an agreed and/or arbitration.

29. Governing Language

29.1 The Contract shall be written in the language specified in SCC. Subject to GCC Clause 30, the version of the Contract written in the specified language shall govern its interpretation. All correspondence and other documents pertaining to the Contract which are exchanged by the parties shall be written in the same language.

30. Applicable Law

30.1 The Contract shall be interpreted in accordance with the laws of the Purchaser's country, unless otherwise specified in SCC.

31. Notices

31.1 Any notice given by one party to the other pursuant to this Contract shall be sent to the other party in writing or by cable, telex, or facsimile and confirmed in writing to the other party's address specified in SCC.

31.2 A notice shall be effective when delivered or on the notice's effective date, whichever is later.

32. Taxes and Duties

32.1 Supplier shall be entirely responsible for all taxes, duties, license fees, etc., incurred until delivery of the contracted Goods to the Purchaser.

PART TWO (PROCUREMENT SPECIFIC PROVISIONS)

- INVITATION FOR BIDS (IFB)
- BID DATA SHEET (BDS)
- SPECIAL CONDITIONS OF CONTRACT (SCC)
- SCHEDULE OF REQUIREMENTS
- TECHNICAL SPECIFICATIONS
- SAMPLE FORM
- ELIGIBILITY

PART TWO
Section I. Invitation for Bids

BALOCHISTAN INTEGRATED WATER RESOURCES MANAGEMENT & DEVELOPMENT PROJECT

INVITATION FOR BIDS (IFB)

Date: 12th April, 2023.

World Bank Credit No.: IDA 58850

1. The **Government of Pakistan** has received credit from International Development Association towards the cost of Balochistan Integrated Water Resources Management and Development Project (BIWRMDP) and intends to apply part of the funds to cover eligible payments under the Contract for Supply of various items for following scheme (Contract):

Sr. No.	Name of Scheme & Contract Identification No.	Scope of Supply	Completion Time (Days)
I	Procurement of Goods for Construction of Sibi Town Water Supply Scheme (PK-PMU-BIWRMDP-353693-GO-RFB)	Supply & Installation of HDPE Pipes, Valves, Pumping Machineries, Solar systems, Transformers and Related Services	240 days

2. The **Project Director, BIWRMDP** now invites sealed bids from eligible bidders for supply of goods for above mentioned scheme.
3. The Procurement will be conducted through **National Competitive Bidding (NCB) method** as specified in the World Bank's Guidelines: Procurement of Goods, Works and Non-consulting Services under IBRD Loans and IDA Credits and Grants by World Bank Borrowers dated January 2011 revised July 2014 ("Procurement Guidelines") and is open to all bidders from eligible source countries as defined in the Procurement Guidelines. In addition, please refer to paragraphs 1.6 and 1.7 setting forth the World Bank's policy on conflict of interest.
4. Interested eligible bidders may obtain further information from **Office of the Project Director, Balochistan Integrated Water Resources Management and Development Project (BIWRMDP)** at the address given below.
5. A complete set of bidding documents in English may be purchased by interested eligible bidders upon submission of a written application to the address below and upon payment of a non-refundable fee of Rs. 3000 for each set. The method of payment will be submission of Green Challan at National Bank of Pakistan in head of Account C03434. The document may be collected in person. Additional Charges of Rs. 500 for each set will be payable if the documents are required through courier. The Bidding Documents are also available on the Project's official website www.biwrmdp.org.pk, but these will not be eligible for participation in the bidding until/unless got formally issued by the office of the Project Director's office
6. A pre-bid conference will be held on **5th May 2023** at 12:00 noon for helping bidder to submit bids free of errors and to respond their queries. Any question/query may be submitted in writing, at least 10 days before the deadline for submission of bids, at the Office of the Project Director, BIWRMDP at the address given below which will be responded accordingly.
7. Bids must be delivered to the address below on or before **12:00 hours of 19th May, 2023** at which time they will be opened publicly in the presence of the bidders' designated representatives and members of the Procurement Committee. Electronic bidding will not be permitted. Late bids will not be entertained for the purpose of evaluation.

8. Bids shall be valid for a period of **91 days** after Bid opening and must be accompanied by security of **2%** of the Bid Price.
9. All bidders shall be required to submit with their bids, qualification information specified in the bidding documents. This information shall be used to establish through post-qualification whether the bidder is qualified to supply.
10. Bids are required to be submitted on item rate basis (not on the basis of Composite Schedule of Rates with percentage premium) and the rates and amounts (in Rupees) must be filled by the bidder for each item in the Bill of Quantities and provide a total price. Non-compliance may result in rejection of bid. Bidders should give their best and final price in their bids as no negotiations are expected.
11. As provided in the bidding documents, bidders engaged in corrupt or fraudulent practices (including collusion/pooling) will be declared ineligible, either indefinitely or for a stated period of time, to be awarded a contract financed by the World Bank.
12. The address(es) referred to above is:

Office of Project Director, Balochistan Integrated
Water Resources Management & Development Project
18-B, Jinnah Town Samungli Road Quetta.
Attn: Mr. Barkatullah, Project Director
Tel: 081-2870705
Fax: 081-2870704
E-mail: bssip@yahoo.com
Web site: biwrmdp.org.pk

Section II Bid Data Sheet

Bid Data Sheet

The following specific data for the goods to be procured shall complement, supplement, or amend the provisions in the Instructions to Bidders (ITB) Part One. Whenever there is a conflict, the provisions herein shall prevail over those in ITB.

Introduction		
ITB 1.1	Name of Borrower	The Borrower is: Islamic Republic of Pakistan Credit Number 5880-PK. Loan or Financing Agreement amount: 110 Million USD (United State Dollar) and a portion of the funds shall be applied to eligible payments under the contract for which these Bidding Documents are issued.
ITB 1.1	Loan Number	IDA 58850
ITB 1.1	Name of Project	Balochistan Integrated Water Resources Management and Development Project.
ITB 1.1	Name of Contract	Procurement of Goods for Construction of Sibi Town Water Supply Scheme (PK-PMU-BIWRMDP-353693-GO-RFB)
ITB 2	Eligible Bidders	A list of firms debarred from participating in World Bank projects is available at http://www.worldbank.org/debarr
ITB 4.1	Name of Purchaser	Project Director, Balochistan Integrated Water Resources Management and Development Project.
ITB 6.1	Purchaser's Address for clarification of Bidding Documents	Project Director, Balochistan Integrated Water Resources Management and Development Project. Street Address: 18-B, Jinnah Town Floor/ Room number: Not Applicable City: Quetta ZIP Code: 87300 Country: Pakistan Telephone: +92-81-2870705 Facsimile: +92-81-2870704 Electronic mail address: bssip@yahoo.com Requests for clarification should be received by the Purchaser no later than 10 days prior to the deadline for bid submission. Clarification shall be in the form of hard copy letter. The clarification shall be sent also by fax or preferably as a scan of the letter attached to an email.
ITB 8.1	Language of the Bid	The language of the bid is: English. All correspondence exchange shall be in English language. Language for translation of supporting documents and printed literature is English.
ITB 9	Additional Requirements	The Bidder shall submit the following additional documents in its bid: <ol style="list-style-type: none">1. The certification by the manufacturer that the equipment is brand new, latest and suitable for outdoor applications having ISO (International Standards Organization) Certification, CE (European Conformity) or equivalent, quality assurance certificates and references.2. The equipment literature, catalogues/brochures and operating manuals, servicing and maintenance of each sub system including all block diagrams and detailed circuit diagrams.3. Brand names/manufacturers represented.

		<p>4. Schedule of Technical Data for each item of the equipment.</p> <p>5. Compliance/Non-Compliance Statement:</p> <p>The bidder shall submit a detailed item-wise compliances/non-compliance statement referring Para- wise to the requirements given in this document. In case the original brochures do not contain the description of any of the specification, it shall be supported by a compliance undertaking by the manufacturer. Make and models of all the equipment should be given.</p> <p>Compliance/noncompliance statement shall be submitted with hard and soft copy.</p>
Bid Price and Currency		
ITB 11.2	List of incidental services	<p>Incidental services to be provided are: -</p> <p>(i) Installation of Hardware including any charges incurred in ware housing pipes and accessories.</p> <p>(ii) Operational including emergency and routine maintenance training to Purchaser's staff.</p>
ITB 11.5	Price shall be	Fixed
Preparation and Submission of Bids		
ITB 13.3 (d)	Qualification requirements.	<p>For a bidder to be considered qualified, it should meet the following requirements:</p> <p>a) Financial Capability The Bidder must meet the following financial requirement(s):</p> <ul style="list-style-type: none"> ▪ Bidder must have liquid assets or credit line facility amounting to Rs. 18.0 million. <p>b) Experience and Technical Capacity The Bidder must meet the following experience requirement(s):</p> <ul style="list-style-type: none"> ▪ Bidder must have executed at least 03 years of experience as supplier of goods. ▪ The bidder can be a supplier or a manufacturer. In case the bidder is a manufacturer, the bidder must have manufactured, tested and supplied the goods, similar to the type specified in the "Specification and Standards" up to at least 100% of the quantity indicated in Bill of Quantities in last three (3) years. Further, the bidder should be in continuous business of manufacturing products similar to that specified in the Specification and Standards during the last Three (3) years prior to bid opening. In case the bidder is not the manufacturer or producer of the goods it offers to supply and has submitted the bid in accordance with ITB clause 13.3 (a), the bidder shall include the above information about the manufacturer whose goods have been offered. ▪ The bidder who is a manufacturer or manufacturer who provided authorization to the bidder should furnish a brief write-up, backed with adequate data, explaining his available capacity and experience (both technical and commercial) for the manufacture and supply of the required goods within specified time of completion after meeting all their current commitments.

		<ul style="list-style-type: none"> ▪ The bidder(s) must submit manufacturer's authorization on the format provided in Section VI of the bidding documents with his bid w.r.t to each item they shall offer in their bid. ▪ The bidder must be registered with local tax authorities. ▪ Training Material (operator's manual etc.) and Training Professionals must be available with Bidder.
ITB 14.3b	Spare Parts	Spare parts required for 10 years of operations
ITB 15.1	Amount of bid security	The amount of Bid Security shall be minimum 2% of the Bid Value in the form of an unconditional Bank Guarantee issued by a Scheduled Bank of Pakistan in local currency. Bid Security shall be valid for 28 (Twenty-Eight) days beyond the validity of the bid.
ITB 16.1	Bid Validity	The bid validity period shall be 91 days.
ITB 17.1	No. of copies.	One original & One additional Copy.
ITB 18.2 (a)	Address for bid submission.	<p>Attention: Project Director, Balochistan Integrated Water Resources Management and Development Project.</p> <p>Street Address: 18-B, Jinnah Town</p> <p>Floor/ Room number: Not Applicable</p> <p>City: Quetta</p> <p>ZIP Code: 87300</p> <p>Country: Pakistan</p> <p>Telephone: +92-81-2870705</p> <p>Facsimile: +92-81-2870704</p> <p>The deadline for the submission of bids is:</p> <p>Date: 19th May 2023</p> <p>Time: 1200 Hours.</p>
ITB 18.2 (b)	IFB title and number.	<p>IFB Title: Procurement of Goods for Construction of Sibi Town Water Supply Scheme</p> <p>IFB No. PK-PMU-BIWRMDP-353693-GO-RFB</p>
ITB 19.1	Bid submission. deadline	12:00 hours on 19th May 2023.
ITB 22.1	Time, date, and place for bid opening.	<p>12:30 hours on 19th May 2023 at</p> <p>Project Director, Balochistan Integrated Water Resources Management and Development Project.</p> <p>Street Address: 18-B, Jinnah Town</p> <p>Floor/ Room number: Not Applicable</p> <p>City: Quetta</p> <p>ZIP Code: 87300</p> <p>Country: Pakistan</p> <p>Telephone: +92-81-2870705</p> <p>Facsimile: +92-81-287070</p>
Bid Evaluation		
ITB 25.3	Criteria for bid evaluation.	<p>A bidder has to quote one rate only. No alternate model or separate accessories will be accepted. Following provisions shall also apply:</p> <p>a) Incidental costs: These, if quoted separately by bidders shall be added to total bid price while determining lowest evaluated bidder.</p>

		<p>b) Delivery schedule: If a bidder offers delayed delivery schedule, its bid will be rejected. No grants shall be given for early deliveries.</p> <p>c) Deviation in payment schedule: The Purchaser may consider the alternative payment schedule offered by the selected Bidder. However, if the alternate payment schedule was not acceptable to Purchaser, bid shall be rejected.</p> <p>d) Cost of spare parts: This factor shall not be considered.</p> <p>e) Spare parts and after sales service facilities in the Purchaser's country: These should be available in purchaser's country. Bid will be liable rejection upon non-compliance.</p> <p>f) Operating and maintenance costs: The goods must meet requirements illustrated in Technical Specifications. Non-compliance may result in rejection of bid.</p> <p>g) Performance and productivity of the equipment: The goods must meet requirements illustrated in Technical Specifications. Non-compliance may result in rejection of bid.</p>
Contract Award		
ITB 29.1	Percentage for quantity increase or decrease	<p>The maximum percentage by which quantities may be increased is: 15%</p> <p>The maximum percentage by which quantities may be decreased is: 15%</p>

Section III

Special Conditions of Contract

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Special Conditions of Contract

The following Special Conditions of Contract shall supplement the General Conditions of Contract. Whenever there is a conflict, the provisions herein shall prevail over those in the General Conditions of Contract. The corresponding clause number of the GCC is indicated in parentheses.

1. Definitions (GCC Clause 1)

GCC 1.1 (g)—**The Purchaser is:** The Project Director, Balochistan Integrated Water Resources Management & Development Project.

GCC 1.1 (h)—**The Purchaser's country is:** Islamic Republic of Pakistan.

GCC 1.1 (k)—**The Project Site is:** The final destinations are:
The sites for supply and installation of the equipment are located in District Sibi, Province Balochistan as shown in drawings.

2. Country of Origin (GCC Clause 3)

All countries and territories as indicated in Part Two Section VII of the bidding documents, "Eligibility for the Provisions of Goods, Works, and Services in Bank-Financed Procurement".

3. Performance Security (GCC Clause 7)

GCC 7.1—The amount of performance security, as a percentage of the Contract Price, shall be: 5 % in shape of unconditional & irrevocable Bank Guarantee from any schedule Bank of Pakistan as per the format provided in these Bidding Documents.

GCC 7.3 (b) – Deleted

GCC 7.4—After delivery and acceptance of the supplies, the performance security of 5% shall be kept by the Purchaser to cover the Supplier's warranty obligations in accordance with Clause GCC 15.2. The Bank Guarantee against performance security will be released upon expiry of the Warranty Period.

4. Inspections and Tests (GCC Clause 8)

GCC 8.1—**Inspection and tests prior to shipment of Goods and at final acceptance are as follows:** These are listed in Section V - Technical Specifications. However, purchaser reserves the right to ask for any test(s) other than the listed ones.

5. Packing (GCC Clause 9)

GCC 9.2—The bidder shall deliver the supplies at the destination in scratch less condition within the manufacturer supplied packing and manufacturer's manuals, booklets, accessories etc. Manufacturer's original Operating Manual must be provided.

6. Delivery and Documents (GCC Clause 10)

GCC 10.3—Upon shipment, the Supplier shall notify the Purchaser the full details of the shipment, including Contract number, description of Goods, quantity and usual transport document. The Supplier shall mail the following documents to the Purchaser:

- (i) copies of the Supplier's invoice showing goods' description, quantity, unit price, and total amount;

- (ii) original and two copies of the usual transport document (for example, a negotiable bill of lading, a non-negotiable sea waybill, an inland waterway document, an air waybill, a railway consignment note if the Supplier is importing items for supplying to Programme or a road consignment note, or a multimodal transport document, if applicable any) which the buyer may require to take the goods;
- (iii) Manufacturers or Supplier's warranty certificate;
- (iv) Manufacturer's inspection certificate issued by the manufacturer.
- (v) Delivery inspection certificate.
- (vi) Export License
- (vii) Electronic Export Information Filing
- (viii) Commercial Invoice
- (ix) Certificate of Origin
- (x) Insurance Certificate
- (xi) Export Packing List
- (xii) Any other document as required by the Purchaser

7. Insurance (GCC Clause 11)

GCC 11.1— The Goods supplied under the Contract shall be delivered duty paid (DDP) under which risk is transferred to the buyer after having been delivered, hence insurance coverage is sellers' responsibility. Since the Insurance is seller's responsibility, they may arrange appropriate coverage but Programme shall require no documentation.

8. Incidental Services (GCC Clause 13)

GCC 13.1 – Incidental services to be provided are: -

- (iii) Installation of Hardware and
- (iv) Operational including emergency and routine maintenance training to Purchaser's staff.

GCC 13.2 – The bidder shall include the price of incidental services in its bid. The Purchaser shall not pay any amount separately on account of incidental services if not included in the contract price.

9. Warranty (GCC Clause 15)

GCC 15.2—In partial modification of the provisions, the warranty period of the supplied Hardware shall be the 12 months from date of acceptance of the supplies. The Supplier shall, in addition, comply with the performance and/or consumption guarantees specified under the Contract. If, for reasons attributable to the Supplier, these guarantees are not attained in whole or in part, the Supplier shall, at its discretion, either:

- (a) Make such changes, modifications, and/or additions to the Goods or any part thereof as may be necessary in order to attain the contractual guarantees specified in the Contract at its own cost and expense and to carry out further performance tests in accordance with SCC 4,

or

- (b) Pay liquidated damages to the Purchaser with respect to the failure to meet the contractual guarantees. The rate of these liquidated damages shall be 0.5 % per week up-to maximum 10 % of the total price.

GCC 15.4 & 15.5—**The period for correction of defects in the warranty period is 30 (Thirty) days.**

10. Payment (GCC Clause 16)

GCC 16.1—The method and conditions of payment to be made to the Supplier under this Contract shall be as follows:

Payment for Goods supplied:

Payment for Goods supplied shall be made in Pak Rupees as per following schedule:

- (i) **Advance Payment:** Ten (10) percent of the Contract Price of Goods shall be paid to the Supplier within thirty (30) days of signing of the Contract against a receipt of invoice and an unconditional bank guarantee valid until delivery date for the equivalent amount and in the form provided in the bidding documents or another form acceptable to the Purchaser. If advance payment is not availed by the Supplier, this 10% amount shall be due to be paid on delivery. A Bank Guarantee will not be required in that case.
- (ii) **On Delivery:** Forty (40) percent of the Contract Price of Goods shall be paid on receipt of the Goods at respective installation sites and upon submission of the documents specified in GCC Clause 11.
- (iii) **On Installation:** Twenty-five (25) percent of the Contract Price of Goods shall be paid to the Supplier on Installation of the equipment at respective sites.
- (iv) **On Acceptance:** Fifteen (15) percent of the Contract Price of Goods shall be paid to the Supplier within thirty (30) days after the date of the acceptance certificate for the respective delivery issued by the Purchaser.
- (v) **On Completion of Defect Liability Period:** Remaining Ten (10) percent of the Contract Price of Goods shall be paid to the Supplier within 30 days after the expiry date of completion of the Defect Liability Period (Warranty Period).

All applicable taxes shall be deducted at source as per applicable taxation laws, while making the payments.

Payment for Related Services:

Payment for Related Services shall be made in Pak Rupees as per following schedule:

- (i) **On Delivery:** Ninety percent (90%) payment of Contract Price of Related Services shall be paid on successful installation, testing and commissioning of the supplied goods after issuance of joint inspection certificate by the inspection committee constituted by the Purchaser and upon submission of the documents specified in GCC Clause 13.
- (ii) **On Acceptance:** Remaining Ten (10) percent of the Contract Price of Related Services shall be paid to the Supplier within 30 days after the expiry date of completion of the Defect Liability Period (Warranty Period).

All applicable taxes shall be deducted at source as per applicable taxation laws, while making the payments.

11. Prices (GCC Clause 17)

GCC 17.1—**Prices shall be:** Fixed, will not be subject to any variation at any stage of bidding and/or supply & installation.

12. Liquidated Damages (GCC Clause 23)

GCC 23.1—**Applicable rate:** Applicable rates shall not exceed one half (0.5) % per week and the maximum shall not exceed 10 % of the contract price.

13. Resolution of Disputes (GCC Clause 28)

GCC 28.3—**The dispute resolution mechanism to be applied pursuant to GCC Clause 28.2 shall be as follows:**

In the case of a dispute between the Purchaser and the Supplier, the dispute shall be referred to adjudication or arbitration in accordance with the laws of the Islamic Republic of Pakistan.

14. Governing Language (GCC Clause 29)

GCC 29.1—**The Governing Language shall be:** English.

15. Applicable Law (GCC Clause 30)

GCC 30.1—The Contract shall be interpreted in accordance with the laws of Islamic Republic of Pakistan which includes the following legislation:

The Employment of Children (ECA) Act 1991
The Bonded Labor System (Abolition) Act of 1992
The Factories Act 1934

The Secretary, Department of Law, Justice and Human Rights or his nominees shall act as the sole arbitrator.

16. Notices (GCC Clause 31)

GCC 31.1—**Purchaser's address for notice purposes:**

Attention: **Project Director, Balochistan Integrated Water Resources Management and Development Project.**

Street Address: **18-B, Jinnah Town, Samungli Road Quetta.**

Floor/ Room number: Not Applicable

City: **Quetta**

Post Code: **87300**

Country: **Pakistan**

Telephone: **+92-81-2870705**

Facsimile number: **+92-81-2870704**

Electronic mail address: bssip@yahoo.com

—**Supplier's address for notice purposes:**

Section IV

Schedule of Requirements

1. List of Goods and Delivery Schedule

Line Item No	Description of Goods	Qty	Physical unit	Final (Project Site) Destination	Delivery Date		
					Earliest Delivery Date following the date of effectiveness the Contract	Latest Delivery Date following the date of effectiveness the Contract	Bidder's offered Delivery date [to be provided by the bidder]
<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>	<i>G</i>	<i>H</i>
	HDPE Main Pipe Line						
3.1	Supply of HDPE Pipes including specials, flanges, valves, including Valve Chambers, etc. complete according to price schedule and specifications.	As defined in Price Schedule	As defined in Price Schedule	Sibi	90 days	180 days	
3.2	Supply of approved quality flanged C.I Gate valve complete according to price schedule and specifications.	As defined in Price Schedule	As defined in Price Schedule	Sibi	90 days	180 days	
	Pumping Machinery						
3.3	Supply of clear water vertical turbine pumps (Discharge 600 gpm, Head = 75 m and HP = 50 HP) complete according to price schedule and specifications.	As defined in Price Schedule	As defined in Price Schedule	Sibi	90 days	180 days	
3.4	Supply of 18" dia MS pipes as manifold with flanged connections for pump delivery pipes 6" complete according to price schedule and specifications.	As defined in Price Schedule	As defined in Price Schedule	Sibi	90 days	180 days	
3.5	Supplying of C.I Air release valve double orifice type PN-10 (Dia 50mm & 75mm)	As defined in Price Schedule	As defined in Price Schedule	Sibi	90 days	180 days	
3.6, 3.7 & 3.8	Supply of solar PV modules, movable mounting structures, inverter, etc. complete in all respect according to price schedule and specifications.	As defined in Price Schedule	As defined in Price Schedule	Sibi	90 days	180 days	
3.9	Supply of Chlorination System with complete accessories from Clean Water Tank to Distribution System.	As defined in Price Schedule	As defined in Price Schedule	Sibi	90 days	180 days	

1. List of Goods and Delivery Schedule

Line Item No	Description of Goods	Qty	Physical unit	Final (Project Site) Destination	Delivery Date		
					Earliest Delivery Date following the date of effectiveness the Contract	Latest Delivery Date following the date of effectiveness the Contract	Bidder's offered Delivery date [<i>to be provided by the bidder</i>]
<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>	<i>G</i>	<i>H</i>
3.10	Supply of Diesel generating set of output 100 KVA at Treatment Plant (continuous), three phase, 4 wire, 380-415 volts, 50 Hz water cooled engine including alternator, skid mounted, electrical start with battery, generator circuit breaker, silencer, anti-vibration pads, control panel with auto mains failure functions, auto synchronizing, auto load sharing functions, power and control cables, common pushbar panel and installation material complete in all respect as per specifications.	As defined in Price Schedule	As defined in Price Schedule	Sibi	90 days	180 days	
3.11	Supply of Transformer 200 KVA, complete in all respect according to specification	As defined in Price Schedule	As defined in Price Schedule	Sibi	90 days	180 days	
	Rehabilitation of Existing Tube Wells						
3.12	Supply of Transformers 50 KVA Complete with all respect.	As defined in Price Schedule	As defined in Price Schedule	Sibi	90 days	180 days	
3.13	Procurement Transformer 100 KVA Complete with all respect.	As defined in Price Schedule	As defined in Price Schedule	Sibi	90 days	180 days	
3.14	Supply of Submersible Pump set of KSB, Grandfos or approved equivalent (similar specifications), complete in all respects according to price schedule and specifications (Submersible Motor Pump Set, discharge @200 gpm at head of 120m and HP 30). The cost includes compatible MCU submersible cable etc. complete. MCU shall have all protections.	As defined in Price Schedule	As defined in Price Schedule	Sibi	90 days	180 days	

2. List of Related Services and Completion Schedule

Service No.	Description of Service	Quantity	Physical Unit	Place where Services shall be performed	Final Completion Date(s) of Services
	General				
As per Specs	Submission of detailed design report including all detailed design features of Supplier's proposed Solar System with mounting accessories, Submersible motor-pump sets, generator sets, transformers, chlorination system and earthing system as per requirements of the contract.	As per Specifications	As Specifications	To be submitted to the Purchaser	30 & 45 days respectively after effective date for draft and final design reports
As per Specs	Establishment of necessary management facilities, physical facilities for installation services, and trained staffing for Installation Services	As Specifications	As Specifications	As per Requirements	As per requirements
	HDPE Main Pipe Line				
4.1 to 4.9	Complete excavation of trenches, laying, jointing, testing and commissioning of HDPE pipelines complete in all respects according to price schedule and specifications (Goods supplied under Items 3.1 & 3.2).	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date
	Pumping Machinery				
4.10	Complete design, installation, testing and commissioning of clear water vertical Turbine pumps (KSB or equivalent) as per requirement coupled with compatible electric motor, including cable compatible MCU to operate motor, cost include C.I gate valve and C.I. non-return valve and 6" dia MS delivery pipe with each pump set connected to the 18" dia MS Manifold. (Goods supplied under Item 3.3)	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date
4.11	Complete design, installation, testing and commissioning of Ms 18" dia pipes as manifold with flanged connections for 4 Nos pump delivery pipes of 6" dia. (Goods supplied under Item 3.4).	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date
4.12	Complete design, installation, testing and commissioning of C.I Air release valve double orifice type PN-10 (Dia 50mm & 75mm) (Goods supplied under Item 3.5).	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date

2. List of Related Services and Completion Schedule

Service No.	Description of Service	Quantity	Physical Unit	Place where Services shall be performed	Final Completion Date(s) of Services
4.13	Complete design, installation, testing and commissioning of complete Solar PV modules, movable mounting structure and foundation civil work, junction boxes, fuses, DC breakers, wiring, etc. complete upto Solar Pump Inverter, (Goods supplied under Item 3.6, 3.7 & 3.8).	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date
4.14	Complete design, installation and commissioning of Chlorination System with complete accessories including two chlorine drums with motorized mixer (3/4 HP) with outlet having tank capacity of 100 gallons. Each from Clean Water Tank to Distribution System (Goods supplied under Item 3.9).	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date
4.15	Complete design, Installation, Testing and Commissioning of Diesel generating sets of output 100 KVA at Treatment Plant (continuous), three phase, 4 wire, 380-415 volts, 50 Hz water cooled engine including alternator, skid mounted, electrical start with battery, generator circuit breaker, silencer, anti-vibration pads, control panel with auto mains failure functions, auto synchronizing, auto load sharing functions, power and control cables, common pushbar panel and installation material complete in all respect as per specifications (Goods supplied under Item 3.10).	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date
4.16	Complete design, Installation, Testing and Commissioning Transformer 200 KVA, complete in all respect according to specification and price schedule (Goods supplied under Item 3.11).	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date
	Rehabilitation of Existing Tube Wells				
4.17&4.18	Complete design, installation and commissioning of Transformers (50 kVA & 100 kVA) complete in all respect according to specification and price schedules (Goods supplied under Item 3.12 & 3.13).	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date

2. List of Related Services and Completion Schedule

Service No.	Description of Service	Quantity	Physical Unit	Place where Services shall be performed	Final Completion Date(s) of Services
4.19	Complete design, Installation, Testing and Commissioning of Submersible Pump Set of KSB, Grandfos or approved equivalent (similar specifications), complete in all respects including all taxes. Submersible Pump Set, discharge @200 gpm. at head of 120m and Hp 30. The cost includes compatible MCU submersible cable etc complete. MCU shall have all protections (Goods supplied under Item 3.14).	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date
	Construction of Pump House (Room size: 5m x 10m)				
4.20 thru 4.40	Complete supply, installation, testing and construction of pump house according to specification and drawings	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date
	Construction of O. H. W. Tank 20,000 Gallons				
4.41 thru 4.57	Complete supply and construction of O.H.W. Tank 20,000 Gallons according to specification and drawings	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date
	Construction of Boundary Wall				
4.58 thru 4.65	Complete supply and construction of boundary wall according to specification and drawings.	As per Price Schedules & Specifications	As per Price Schedules & Specifications	Sibi District as shown in Drawing.	240 days after effective date

Section V. Technical Specifications

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TECHNICAL SPECIFICATIONS

PART I - SPECIAL PROVISIONS

1 General

1.1 The Requirement

It is required to supply machinery and equipment and complete related services such as design, installation, erection, testing, commissioning and maintenance in accordance with the stipulated Conditions of the Contract, and this technical specification (special and technical provisions) and the drawings under the Contract for Procurement of Goods for the Construction of Sibi Water Supply Scheme.

All matters omitted from the documents, which may be inferred to the supplies and related services shall be deemed to be included.

The whole of the machinery, equipment, apparatus and structures shall be arranged generally as shown as on the Drawings and in accordance with the specification

The rating given is estimated only and the Supplier shall ensure that all equipment being supplied is adequately rated to meet the requirements of the specification and the duties thereon.

The Supplier shall supply complete Machinery and Equipment including solar panels, battery backup, turbine pumps, motors, motor control panels, water supply pipelines, valves and fittings, mechanical works, spare parts and other to complete the job including operation and maintenance equipment to be provided as specified.

1.2 Location

The Project area is situated in Sibi, District Sibi, and Province Balochistan of Pakistan. The Supplier shall be responsible for the supply of machinery and equipment and execute related services in Sibi.

1.3 Contract Packages

The complete scope of work of the Sibi Water Supply Scheme is divided in following three Contracts. The minimum but not limited scope of works and responsibilities of the Supplier are described below.

Contract for Procurement of Civil Works for Construction of Sibi Water Supply Scheme

The following Civil Works are covered in the above Contract:

Contract for Lot 1 - Works at Nari River (Sibi)

- Construction of Sump Well & Sump Well Room
- Construction of Conduit Channel

Contract 2 - Works at Treatment Plan (Sibi)

- Construction of Sedimentation Tank (03 Nos)
- Construction of Slow Sand Filters at Treatment Plant (04 Nos)
- Construction of Clear Water Reservoir
- Construction of Over Head -100000 Gln (02 Nos)
- Construction of Sub Engineer Residence
- Construction of Chowkidar Quarter
- Construction of Store Room
- Construction of Guard Room

Contract for Procurement of Goods for Construction of Sibi Water Supply Scheme (this Contract)

The following scope of Supplies and related services are covered in the subject Contract:

A - Pipeline and Valves

The following activities are included in this respect:

- Excavation and refilling of trenches including supply & spreading of sand in trenches, cutting of asphalt roads, construction of concrete thrust block, construction of chambers for valves, etc.
- Supplying, laying, jointing, testing and commissioning of HDPE pipelines
- Supply and installation of C.I gate valve in the constructed chambers as above.

B – Pumping Machinery

The following activities are included in this respect:

- Supply, design, installation, testing and commissioning of clear water vertical Turbine pump (KSB or equivalent) as per requirement coupled with compatible electric motor, including cable compatible MCU to operate motor, cost include C.I gate valve and C.I. non-return valve and 6" dia MS delivery pipe with each pump set connected to the 18" dia MS Manifold. The quoted cost shall include bend, suction line, delivery main with pressure gauge, vibration insulator, etc complete in all respect as desired by Engineer In charge. Control panel shall operate all pumps, two in parallel and on manual -auto-off positions shall have all protections, i-e dry-run, thermal and phase. Cost includes control sensors/ float sensors etc. pump motor with high efficiency and compatible to operate on solar power as well (Discharge (Q) = 600 gpm, Head (H) = 75 M and Power = 50 HP)
- Supply, design, installation and testing of Ms 18" dia pipes as manifold with flanged connections for 4 Nos pump delivery pipes of 6" dia. The cost includes all hardware and welding etc. complete with outlet flanged connection upto outside pump well.
- Supply of Solar PV Arrays/ modules of 40 kWp. The Solar PV arrays/ modules shall be "crystalline" type, IEC 61215:2005 certified by German Laboratory TUV/ VDE, ready and complete with all accessories for installation in all respects.
- Supply, Install, connect, test and commission of SOLARMOUNTING STRUCTURE & accessories (Movable).

- Supply of Solar Panel/ Operational Panel having appropriate Inverter, MPPT, Combiner box, DC Energy Meter, DC cables, Hour meter for tube well operation, automatic/ manual control for submersible motor-pump, VFD, main Cu Bus bar (3-Phase+N+E) & TP MCCB adjustable (Main incoming Circuit Breaker) and outgoing MCBs with spares available, Motor-pump set protections (Over Current, Short circuit, Under Current, Under & Over Voltage), DC and AC incoming & outgoing Power cables & wires etc. with all other required accessories. The panel shall be properly compartmentalized and free standing ready and complete with all accessories for installation in all respects.
- Supply, design, installation, testing and commissioning of Chlorination System with complete accessories including two chlorine drums with motorized mixer (3/4 HP) with outlet having tank capacity of 100 gallons. Each from Clean Water Tank to Distribution System.
- Supply, installation, testing and commissioning of Emergency Diesel generating set of output 100 KVA at Treatment Plant (continuous), three phase, 4 wire, 380-415 volts, 50 Hz water cooled engine including alternator, skid mounted, electrical start with battery, generator circuit breaker, silencer, anti-vibration pads, control panel with auto mains failure functions, auto synchronizing, auto load sharing functions, power and control cables, common pushbar panel and installation material complete in all respect as per specifications.

C - Rehabilitation of Existing Tube Well

The following activities are included in this respect:

- Rehabilitation works of Eight Existing nonfunctional tube wells in Sibi District. Rehabilitation works include providing and installation of Transformer 50 kVA, 100 kVA or as specified in the Price schedule complete with all respect.
- Supply, installation, testing and commissioning of Submersible Pump set of KSB, Grandfos or approved equivalent (similar specifications), complete in all respects including all taxes. Submersible Motor Pump Sets, discharge @200 gpm. at head of 120m and HP 30. The cost includes compatible MCU submersible cable etc. complete shall have all protections.

2 Climate

The Supplier shall be deemed to have taken into account all possible weather conditions when preparing his Tenders and his program of Works, and he will not be entitled to any additional payments whatsoever as a result of meteorological phenomena.

The Supplier shall make suitable arrangements to protect the Goods, Temporary Works, Constructional Plant and materials stored on site against the effects of the weather.

No work will be performed by the Supplier when in the opinion of the Purchaser such work is liable to be affected by the weather. The Supplier shall not be entitled to any additional payment on account of loss alleged to have been sustained as a result of the Purchaser declining to permit such work to start or to continue or ordering any work which has been affected by the weather to be removed, and re-executed, or made good.

3 Site Description

The site will include public and private roads, alleyways and lands and shall mean the minimum extent of each such public and private lands as in the opinion of the Purchaser is necessary or practicable for the supply of goods and related services.

The Supplier shall make records to be agreed by the Purchaser of the condition of the surfaces of the Site immediately before entering upon them for the purpose of execution of the supplies and related services.

3.1 Site in Public and Private Land

The Purchaser will serve the necessary notices to permit pipelines to be laid in public and private lands in accordance with the agreed program of work and the Supplier shall not enter on those lands until given permission by the Purchaser. The Supplier shall temporarily fence the Site where the supplies and related services are to be or are being rendered to the satisfaction of the Purchaser and the Supplier shall confine all the works plant, labour, materials and transport within the Site so fenced. The Supplier shall use the Site only for the supply of Goods and execution of the related services.

3.2 Right of Way

Right of way shall be the area (s) allocated to the Supplier to enable execution of the Supplies and related services in accordance with the Contract. Due to physical statutory other special conditions the working width of Right of Way may be restricted (including restricted access to working sites). The Supplier is deemed to have included in Contract Price all costs encountered for complying with such restrictions.

In general, the maximum working width (Right of Way) for any section of pipeline work in agricultural land, garden, etc shall be not more than 6 meters. For isolated compact sites an all around width of 12m beyond the net sizes of the units will allowed, unless the area is otherwise defined by the Purchaser.

In case the Supplier requires areas outside the allocated Right of Way he may, with the prior agreement of the Purchaser, negotiate these on his own behalf and shall be responsible for all costs involved and for the restatement after completion of permanent work.

All fences, walls structures, buildings, etc affected by the Supplier's work shall be reinstated to the satisfaction of the owner and the Purchaser.

3.3 Security of the Works & Persons

Watching and security of the Goods shall be provided by the Supplier at his own expense. If the Purchaser considers it necessary, he will order in writing that additional watchmen be provided all at the Supplier's expense to ensure proper security of Goods and persons associated with the project.

The Supplier shall provide to the Goods and Installations an adequately supported temporary screen or fence in accordance with local bye-laws and to the approval of the Purchaser.

All excavation shall be adequately lit at night complete with hazard warning lights to pedestrians and traffic in accordance with applicable Traffic Police Regulations.

Unfenced openings and surface obstructions shall be attended by days and night and shall be adequately lit at night.

3.4 Closing of Roads

The Supplier shall not close any road unless the Authority having charge of the road surfaces shall have previously given the appropriate notice or made the appropriate order and without the Supplier having first obtained the written consent of the Police and of the said Authority to close the same. In the event of such consent being refused the Supplier shall have no claim for any additional payment. In the event of such consent being given the Supplier shall give warning in advance of the date of the commencement of the road closure to all Statutory Local or other Authorities and public service undertakers as may be affected by such closure and shall provide fix and maintain all warning signs and diversion notices as may be required by the said Authority, by the Police and by the Purchaser.

3.5 Roads and Site to be kept Clean

The Supplier shall take great care and all reasonable precautions to ensure that roads and thoroughfares used by him either for the construction of the Works or for the transport of plant, labour and material are not made dirty as a result of such construction or transport and in the event of their becoming thus dirtied in the opinion of the Purchaser the Supplier shall take all necessary and immediate steps to clean them.

Each individual site must be kept clean during the work and must be thoroughly cleaned up on completion.

4. Codes and Specifications

Material, equipment and workmanship shall conform with all applicable British Standards, or such other standards as may be specified herein or approved by the Purchaser.

If the Supplier proposes the use of alternative standards, he shall allow sufficient time for the Purchaser to check such standards and for carrying out any tests as directed by the Purchaser in order to confirm that materials and equipment to be supplied under alternative standards are of equivalent standard. No claim for testing expenses and for delays arising as a result of time required for carrying out such tests will be accepted.

Whenever requested by the Purchaser, in writing, the Supplier shall procure and provide to the Purchaser two English copies of any standards used in the Supply, Installation, commissioning, testing of equipment.

5. Setting Out of Works

It shall be the Supplier's responsibility to obtain from the Purchaser before commencing the installation work co-ordinates and levels of setting out points, which have already been established by the Purchaser. The Supplier shall use these to establish additional temporary bench marks as necessary throughout the project area. These shall be of a form approved by the Purchaser and maintained until the completion of related services.

The Supplier shall be responsible for the setting out of the installation works. All dimensions and levels shown on the drawings or referred to in any document forming part of the Contract shall be verified by the Supplier on Site. He shall be responsible for pointing out promptly any discrepancy or error in such dimensions or levels.

The Supplier shall prepare detailed setting out drawings and data sheets as necessary and submit them to the Purchaser or his Representative for approval. Any modification of these drawings or data sheets required by the Purchaser shall be made by the Supplier and resubmitted for final approval.

6. Water Supply (Temporary)

The Supplier shall provide at his own expense a temporary supply of potable and other water required, for execution, installation, testing and related services. He shall provide, operate and maintain the supply throughout the duration of the Contract. Quality of water shall be to the satisfaction of the Purchaser.

7. Electricity Supply for Power and Lighting (Temporary)

The Supplier shall arrange for and pay all costs in connection with the temporary supply of electricity he may need for the duration of the Contract. If the Supplier intends to provide his own electricity supply, the regulations of the Pakistan WAPDA are to be observed and the permission of this Authority is to be obtained.

8. Other Services

The Supplier shall make his own arrangements for and shall provide and pay for any services required during the duration of the Contract.

9. Site Conditions

Where pipelines are to be laid close to public highways, the Supplier shall ensure that installations are properly protected at all times, including the provision of day and night traffic signals when necessary.

10. Working Hours

The Supplier shall perform his work only during the standard working hours on construction sites which are 48 hours, distributed over 6 days per weeks, except on holidays.

Should the Supplier wish to carry out works outside normal working hours or on Sunday and public holidays; he shall comply with related requirements and shall do so only after the Supplier has given the Purchaser at least 48 hours' notice in writing.

11. Materials

11.1 Quality of Materials and Workmanship

All materials and equipment to be used in the supplies shall be new and of the required specifications. The workmanship shall also be of the specified quality, all to the approval of the Purchaser.

11.2 Approval of Suppliers of Materials

Before entering into any sub-Contract for the supply of any materials or goods the Supplier shall obtain the Purchaser's approval in writing of the sub-supplier from whom he proposes to obtain such materials or goods. Should the Purchaser at any time be dissatisfied with such materials or goods or with the methods of operation carried out at such sub-supplier's works or place of business, he shall be empowered to cancel his previously given approval of such sub-supplier and to specify and other suppliers whom he may choose or to approve another sub-supplier for the supply of such materials or goods. The Supplier shall then obtain the said materials or goods from such other supplier and shall bear any additional cost thereof.

11.3 Copies of Orders

The Supplier shall provide the Purchaser with three copies of all orders for the Supply of materials and goods required for the Contract.

11.4 Samples

In addition to specific provisions in the Specifications for sampling and testing of materials, the Supplier shall submit to the Purchaser, as he may require, samples of all materials which he proposes to use under the Contract. When approved, these will be retained by the Purchaser.

Samples to be submitted shall be accompanied by an approved form on which all information about specifications, description, location of use, manufacturers etc. are stated.

The Supplier is advised to submit a "Materials Procurement Program" for all materials and equipment which are deemed to be used in the permanent works indicating dates for sampling, approval, ordering, delivering to site.

The Purchaser may reject any materials or goods, which in his opinion are inferior, to the samples submitted.

The Purchaser's approval of manufacturers or materials for the Goods, whenever required by the Specifications, shall not relieve the Supplier of his responsibilities under the Contract.

11.5 Tests

The Purchaser may examine and may require testing of any materials or goods to be supplied at any place inside or outside Pakistan. The Supplier shall give the Purchaser unrestricted access to his and his Sub-supplier's premises and suppliers for such purposes at all times.

The Supplier shall afford the Purchaser all facilities, assistance, labour and appliances necessary for the convenient examination, testing, weighing or analysis of all materials and goods. The Supplier shall prepare test samples, which the Purchaser may require.

Tests carried out off the site shall not relieve the Supplier of the responsibility of ensuring that the materials pass any required tests when they are incorporated in the Equipment.

The costs of all tests prescribed in the Specifications are to be borne by the Supplier and are deemed to be included in his contract prices. The costs for any additional tests required by the Purchaser shall be borne by the Purchaser.

11.6 Test Certificates

The Supplier shall obtain Test Certificates from his supplier and forward three copies of such certificates to the Purchaser. Such certificates shall certify that the material or goods have been tested in accordance with the Specifications and British Standards, and shall give the results of the tests which have been carried out. As regards the major project equipment the Supplier shall ensure that the tests are carried out in the presence of the Purchaser's representative.

The Supplier shall provide adequate means on site to identify the materials or goods with their respective test certificates.

12. Pollution of Drains and Waterways

The Supplier shall take all necessary precautions to secure the efficient protection of all waterways against pollution including spillage of oil or concrete mixer wastes, site drainage or any other harmful materials. The Supplier shall seek the Purchaser's approval before discharging any substance that may degrade groundwater quality. If nevertheless, such spillage occurs, the Supplier shall clean the waterway at his own expenses, and keep the Purchaser indemnified against any claim arising from such pollution during the execution of the Supplies and Related Services and the Period of Maintenance.

13 Damage to Services

The Supplier will be held responsible and shall pay all costs related to damages to private property or roads, bridges, irrigation ditches, mains, pipes, electric cables, lines or services of any kind caused by him or any of his sub-suppliers during the execution of the Contract.

The Supplier shall make good or arrange to make good at his own expense any damage without delay, and shall carry out any further remedial work ordered by the Purchaser.

The Supplier shall make good at his own expenses any damage without delay to the pipes during the installation works. Lining should be repaired according to manufactures instructions.

14 Drawings

14.1 Bid Drawings

Drawings provided with the Biddings Documents are Bid drawings. Bid Drawings show the scope of the work to be performed by the Supplier. The Bid Drawings shall not be used as a basis for fabrication or installation but may be used as a basis for placing preliminary orders for materials, subject to corrections based on the future issue of drawings issued for Construction. Any other drawings if issued through Addenda, before opening of Bids, shall be part of the Bid Drawings.

Copies of Contract Drawings, Construction Drawings and Specifications

One complete set of Contracts Documents, Construction Drawings and Specifications will be issued to the Supplier free of charge. The Supplier may make further copies to suit to his requirements.

15 Working Drawings

The Supplier shall incorporate in the drawings all openings, ducts, recesses, anchor holes, etc. as required for the mechanical and electrical installations. All related costs are considered included in the Contract Price.

The title block shall be as on the Tender Drawings. And shall show in addition the Supplier's name and the descriptive name of the Works shown on the drawing. Materials and material Standards shall be indicated on the drawings.

Drawings from Sub-Suppliers shall be checked signed and stamped by the Supplier being forwarded to the Purchaser, who shall deal in all respects only with the Supplier.

When the Purchaser or his representative approves a Working Drawings, he shall return a copy marked "Approved" to the Supplier, who shall then insert the date of approval on the tracing and furnish the purchaser with three prints of the working drawings as approved.

Approval of a working drawing by the Purchaser will only signify his general approval of the design and shall not make him liable for any error of the Supplier in details or lack of strength or efficiency of any part. Where errors, deviations and / or omissions are discovered later, they shall be made good by the Supplier at his own expense irrespective of any approval by the Purchaser.

16 Technical Records

The Supplier shall submit to the Purchaser not later than one month before commissioning draft copies in English of technical data as the following:

- Information on suppliers (address, fax, telephone) of pipes, solar system, pumps, fittings, etc. for water supply, solar and pump systems.
- Full technical documentation for the above items.
- Step-by-step description of the preparation and setting to work of the whole of the water supply system including pipes, valves etc.

Not later than the time at which the works are taken over, the Supplier shall provide four copies of instruction manuals in English to the approval of the Purchaser to cover all details of normal operation of each item and requirements regarding its functional relation with the plant as a whole and of all the individual items, together with routine maintenance instructions.

17 Record Drawings and Manuals

Prior to commissioning the Supplier shall provide for use by the Purchaser.

- i. Three draft copies of the operating and Maintenance Manual for all sections of the Equipment complete with-up-to date drawings together with draft of the board mounted schedules.
- ii. Six copies of recommendations giving type and quality of consumable supplies e.g., packing's, lubricants, etc., for the equipment installed.

The works shall not be considered to be complete until the above information has been supplied to and approved by the Purchaser.

After Equipment erection has been completed, the Supplier shall submit to the Purchaser four copies of the following 'As Erected' and 'As Fitted' drawings for approval.

- i. Drawings showing the internal construction of the major items, with parts list and reference numbers for ordering spares.
- ii. Complete assembly drawings of machinery and ancillary equipment showing all pipework, connections and fittings, etc.
- iii. General arrangement drawings showing all mechanical and electrical equipment include cabling, conduiting/ tray work, etc.
- iv. Detailed arrangement of any conduit work buried in floors, walls, ceilings, in any structure.

- v. Detailed wiring, overhead line and underground cable routes and electrical layout and schematic diagrams of the main circuits.
- vi. Control gear general arrangement, schematic and wiring diagrams.
- vii. Diagrams of connections between all items of equipment (e.g. main and auxiliary switchboards, control boards, motors, starters, meters, instruments, relays, electronic and allied equipment's, etc., with component values and types suitably marked thereon).
- viii. Detailed revised specification and schedules of the plant as actually installed.

The above requirements shall be fulfilled to the satisfaction of the Purchaser before the Completion Certificate is issued. When items (i) to (viii) inclusive have been approved by the Purchaser, the Supplier shall provide two black and white prints of each on thick paper for the use of the Purchaser together with one full plate negative of each.

All reproducible record drawings shall be on durable and unbearable plastic film or linen. The Supplier shall also provide, suitably framed and protected for wall mounting.

- i. One copy of drawings showing the location and position of all pipe runs and valve positions, all correctly numbered with matching numbers on the equipment.
- ii. One copy of site overhead line and underground cable diagrams showing the location and position of all cable runs and termination positions all suitably numbered.

18. Operating and Maintenance Instruction Manuals

The Supplier shall submit to the Purchaser not later than one month before commissioning, triplicate draft copies of the Operating and Maintenance Instructions in English for all sections of the Equipment.

The draft operating instructions shall be prepared in such a way as to provide a step-by-step description of the preparation and setting to each part of equipment and its shutting down.

The draft instruction manuals prepared by the Supplier and manuals relating to equipment supplied by any sub-suppliers shall be printed (not duplicated) and shall be bound into suitable loose-leaf binders A4 size.

Following successful commissioning and not later than one months after the Purchaser has accepted the equipment, the draft copies, suitably corrected where necessary, shall be assembled into their final form and shall be submitted to the Purchaser for approval prior to handing to the Purchaser.

The Supplier shall provide six copies of the final instruction manuals, in English, operating, maintenance and safety procedure necessary for the routine operation of the works.

Any additions, alterations or deletions which may be required by the Purchaser following the experience gained during the periods of running and further maintenance shall be incorporated in

these six copies in the form of additional or complete replacement pages and the cost of these amendments shall be deemed to be included.

The Purchaser's attention is drawn to the need to ensure that the following items are included in the Operating and Maintenance instruction Manuals:

- i. Schedule of equipment supplied giving manufacturers name and appropriate Make / Model No. / Cat. No.
- ii. Schedule of routine maintenance for all equipment supplied.
- iii. Schedule of spares supplied.
- iv. Schedule of tools and lubricants supplied.
- v. Sectional arrangement drawings of major items of equipment i.e. pumps, valves, etc., with dismantling instructions.
- vi. Equipment layout drawings showing the "As Erected" installation.
- vii. General arrangement and schematic diagrams of the "As Installed" control panels.
- viii. "As wired diagrams of all electrical connections, between the control panel and installed equipment.
- ix. Full and comprehensive instructions for all items of equipment supplied.
- x. Test certificates for both works and site tests of equipment including motors, pumps, and other electrical equipment where appropriate.
- xi. Pump performance curves as tested.
- xii. System Curves.
- xiii. Schedule of recommended lubricants their equipment's which must be readily obtainable on the nearby market in Quetta.

At each location for each type of equipment there shall be supplied and mounted on the wall in a conspicuous position as determined by the purchaser, the following schedules.

1. No. Board mounted schedule of Routine Maintenance to be carried out on equipment.
- 1 No. Board mounted set of Instructions for Operation of the plant.

The print on each board is to be of large clear type in Arabic and English.

Boards shall be neatly finished plywood and shall be suitably protected by clear varnish or other approved material.

The issue of the Completion Certificate shall be subject to receipt and approval by the Purchaser of the draft Operating and Maintenance Instruction Manual and of draft of the above-board mounted schedules.

19 Supplier's Monthly Reports

19.1 Progress Reports

The Supplier shall report monthly progress to the Purchaser on charts submitted in triplicate showing actual work done superimposed on copies of his agreed program. He shall provide an explanation for any deviation from his program and shall in the case of delays propose strategies for improving progress.

The reports shall be delivered to the Purchaser within one week after the end of each month.

19.2 Labour and Plant Returns

The Supplier shall include with his monthly reports details of all equipment, (including their values) and labour force employed on the Site together with a description of their deployment. He shall also provide list of all materials and equipment intended for use at the Site related to the supply of goods and to execute the related services.

19.3 Photographic Records

The Supplier shall provide a photographic record of the supply of goods at the site and execution of the related services by having photographs taken during the delivery of equipment at site, installation, testing, commissioning and inspections of the equipment, etc. as the purchaser may specify from time to time. The number of such photographs shall not exceed ten per month.

The Supplier shall supply three sets of color prints, size 9x13 cm mounted on album sheets, dated and described.

All the costs related to the preparation and submission of progress report and photographic records shall be deemed to be covered in the contract price.

20. Supplier's Compounds

No separate item is provided in the price schedules to cover the cost to the Supplier of providing and maintaining the offices, compounds, workshop and housing necessary for the proper organization and superintendence of the supplies of goods and execution of related services. These are deemed to be included in all other items of works. The Supplier shall be responsible to arrange the necessary land for the compounds at his own expense.

The Supplier has to submit to the Purchaser the layout and design of his compounds showing areas required for workshops, garages, concrete yards, stores, housing etc., for his approval.

The compounds and their contents shall be dismantled and cleared away by the Supplier at the completion of the Contract.

The Supplier shall provide, erect and maintain sign boards at his own expense at locations to be indicated by the Purchaser. They shall be lettered in Balochi and English and be not smaller than 3 m x 2 m in size. The wording shall be as directed by the Purchaser.

21. Control of Construction Noise

The Supplier shall employ the best practical means to minimize noise and vibration produced by his operations. These shall include but not be limited to the following:

- (a) All vehicle and mechanical plant shall be fitted with effective exhaust silencers and shall be maintained in good and efficient working order.
- (b) All compressors shall be “sound reduced” models fitted with lined and sealed acoustic covers which shall be kept closed whenever the machines are in use and all ancillary pneumatic percussion tools shall be fitted with mufflers or silencers. Dampened bits shall be fitted to percussion tools.
- (c) Machines in intermittent use shall be turned off or throttled down when not in use.
- (d) All pumps shall be fitted with effective exhaust silencers where appropriate, and maintained in good and efficient working order. Pumps running overnight shall be effectively silenced. Alternatively the Supplier shall use electrically driven pumps if necessary.
- (e) All stationary plant shall be screened where possible.

22. Entry to Private Land

Where it is necessary to enter on privately owned land for the purpose of making temporary road diversions, or for any other reason, the landowner or occupier shall first be consulted by the Supplier and his written permission obtained.

The Supplier shall ensure that, in case the landowner or occupier refuses access, the Purchaser is informed at least 6 weeks before the intended start of work in the area concerned.

Care shall be taken that no undue damage is caused to land, and at the completion of the work, the land shall be left in a tidy and restored (if appropriate) condition to the satisfaction of the landowner or occupier and the Purchaser.

23. Safety Measures and Services

The Supplier shall be responsible for the safety and health of the all workmen and other persons in or around the Installation and related works, to the satisfaction of the Purchaser. Such measures shall include, but not be limited to, the following:

- Provision of proper safety and emergency regulations, fire, gas and electric shock prevention, stretchers and first aid box together with rescue facilities generally at each place of work.
- Adequate supports and braces for all excavations.
- Provision of sufficient safety helmets for all personnel including the Purchaser, his staff, and

any authorized visitor to the Site.

- Safe control of water including the provision of standby pumping plant.
- Provision and maintenance of safe, sound ropes, slings, pulleys and other lifting equipment, each having an up-to-date test certificate.
- Provision and maintenance of safe, sound mechanical frames, hoists, cranes, and vehicles for transporting materials, with an up-to-date test certificate for each item.
- Provision of good and safe access to the Works.
- Provision of warning notices to the public in English, Balochi and Urdu warning them of the existence of any dangers from the Works.

The Supplier shall ensure that employees are available at each site to administer emergency first aid and that all employees are aware of their names. The Supplier shall provide for the transport of serious cases to hospital. All medical facilities shall also be to the satisfaction of any properly appointed medical officer authorized by the Government of the Balochistan to inspect medical facilities at Site.

The Supplier shall ensure that all his employees are fully conversant with regulations and emergency procedures, and shall enforce the rule that any employee committing a serious breach of such regulations shall be immediately dismissed and shall not be re-employed.

24. Sanitary Arrangements

The Supplier shall provide and maintain sufficient sanitary conveniences for all operatives and site staff engaged on the supplies of goods, installation and related services. These shall be in accordance with any requirements and regulations of the Government of the Pakistan and subject to the approval of the Purchaser. The ground shall be disinfected at the end of the Contract.

The Supplier shall ensure that all operatives and staff are aware that the sanitary conveniences of must be used by all personnel, and the Purchaser reserves the right to require dismissal of any person committing a nuisance on or about the site by failing to use the conveniences provided.

25. Working Programme

Before commencing installation services, the Supplier shall record any existing damage to adjacent buildings and notify the Purchaser thereof. Failing to do so, the Supplier may become liable to make good such damage at his own expense as it may be considered a result of result of his activities.

26. Training of Staff

The Purchaser will delegate to the Supplier a team of Operation engineers and technicians to be trained on various sections of the operation, testing and commissioning of the equipment.

The Supplier shall submit for the approval of the Purchaser a training program and shall report to the Purchaser in writing in monthly intervals detailing the activities, attendance, performance and ability of each member of the team.

27. Fencing of the Works

The Supplier shall fence the Works in a manner sufficient for the protection of the public and livestock and property during the progress of the installation works and shall satisfy the Purchaser or his Representative in this respect.

The Supplier shall erect and maintain adequate safety measures around all trenches and other open excavations in a manner sufficient to provide maximum safety to pedestrians and vehicles at all times. Temporary bridges shall be provided across trenches to maintain reasonable and safe access for pedestrians and vehicles to land and property on provide side of trenches.

28. Language of Records

All time sheets, records, notes, drawings, documents, etc. shall be in the English language. If the original documents are in another language a certified translation in English shall be submitted to the Purchaser.

29. Connection to Public Services

The Supplier shall be responsible to obtain in time all necessary approvals from the relevant Balochistan / Federal Government Authorities to connect the works in such a manner as required and approved by these Authorities. The costs involved are deemed to be included in the Contract Price.

30 Supplier's Design Report

Within one month after the effective date of the contract, the Supplier shall prepare and submit a draft detailed design report to the purchaser. The draft detailed design report shall include detailed design aspects, calculations, standards, manufactures details, warranty certificates, type test reports, performance certificates, specifications for the all items of the equipment related to the solar power systems and pumping machinery, generator sets and laboratory equipment as per requirements stipulated in the price schedules and specifications. The design of HDPE pipeline works shall be done by the Purchaser.

The Purchaser shall review the draft design report and provide comments. The Supplier shall incorporate all the comments of the Purchaser and submit the final design report to the Purchaser within 45 days after the effective date of the contract. The approval of the Supplier design report shall not limit any responsibility and liability of the Supplier in accordance with the Contract. The Supplier shall be responsible to complete the supply, installation and all related services according to Specifications and as directed by the Purchaser.

The costs for preparing and submitting the detailed design reports shall be deemed to be included in the contract price.

30.1 General Design Considerations

The Purchaser shall conduct site visit of all four sites at his expense and collect the requisite data which he may require in the preparation of designs. The Purchaser shall provide all the data which is readily available with the Purchaser. However, the Supplier shall be responsible for any additional data and information at his own costs.

The Supplier shall design in all respects to conform to current engineering practice.

The Goods shall be designed in all respects to conform to current engineering practice.

The philosophy of the design shall be simplicity and reliability such that the equipment will give long trouble free service with low maintenance costs. Particular attention should be paid to ease of access to facilitate inspection, cleaning, maintenance and repair.

All equipment supplied shall be designed to meet the needs for satisfactory operation under all variations of operating loads, pressures and temperatures including variation in the ambient temperature.

All materials shall be new and of the best quality and shall be selected to withstand the stresses imposed by the working and ambient conditions without distortion or deterioration affecting the efficiency and reliability of the plant.

It shall be the responsibility of the Supplier to ensure that the electrical equipment is completely satisfactory for use with the mechanical equipment offered.

Each component or assembly proposed in the design report shall have been proven in service in a similar application and under conditions no less arduous than those specified herein. The Supplier shall have the right to request the Supplier justify his selection of equipment. Where it is show that material of equipment is of a standard lower than that necessary to comply with the Specification, the Supplier shall modify or replace the equipment concerned at no extra cost to the Purchaser.

The choice of materials and finishes shall take into account the dry tropical conditions, the frequency of dust storms and the high temperatures encountered at the site Equipment shall be protected against the entry of vermin, termites, and insects of other small animals.

Outdoor equipment shall be weatherproof and designed to prevent the collection of water at any point. Metal-to-metal joints will not be permitted and all external bolts or screws shall be provided with blind tapped holes where a through hole would permit the ingress of moisture.

Mechanisms shall be constructed of materials, which will not stick due to rust, corrosion, brine or dust. Bearings exposed operating shafts shall be designed to prevent moisture seeping along the shaft into the interior of the equipment.

Equipment and instruments shall not be located in positions where they are vulnerable to falling objects or water drips. Weather shields shall be provided where necessary to protect equipment and instruments from the sun.

30.2 Interchangeability

All equipment performing similar duties shall be of a single type and make and fully interchangeable in order to limit the stock of spare parts required.

This is to apply particularly to such items as motors, instruments, controls, valves, etc.

30.3 Materials

All materials proposed in the design report shall be the most suitable for the duty concerned and shall be new and of first class commercial quality, free from imperfections, and selected for long life and minimum maintenance to withstand without distortion the stresses imposed by the working and ambient conditions to be met on site.

31 Compensation included in the Contract price

The rates and prices entered in the Priced Schedules for Goods and Related Services constitute the Contract Price.

The Contract Price shall, except insofar as it is otherwise provided under the Contract include all costs of Supplier's plant, labour, supervision, materials, equipment, machinery, transportation, erection, electricity and fuel, execution, insurance, profit, taxes and duties, together with all general risks, liabilities and obligations set out or implied in the Contract.

The Contract Price shall include the maintenance costs during Defects Notification Period (Warranty Period) of one year and training of Purchaser's staff.

The Schedules do not generally give a full description of the equipment to be supplied and the related services to be performed under each item. Bidders shall be deemed to have read the Schedule of Requirements and other sections of the Bidding Document and reviewed the Drawings to ascertain the full scope of the requirements included in each item prior to filling in the rates and prices. The entered rates and prices shall be deemed to cover the full scope as aforesaid, including overheads and profit.

TECHNICAL SPECIFICATIONS

PART II - HDPE PIPELINE AND APPERTINANCES

1 GENERAL

1.1 Scope

The Supplier shall deliver at Site (s) all the pipes, specials and valves and complete related services for the installation and fixing of pipelines, specials and valves according to the specification as shown in Drawings and included herein under the Contract. The Supplier shall be responsible for all supplies and related services according to this specification and as directed by the Purchaser.

1.2 Storage

All material provided by the Supplier have to be stored in a proper storage area to the approval of the Purchaser.

The Supplier shall construct a fenced, lockable compound in which all pipes, valves and fittings, whether purchased abroad or manufactured locally, are to be delivered.

The Supplier shall be responsible for cleaning, leveling and enclosing the site storage area to be provided by the Supplier and shall provide all the necessary security. He shall also provide shelters of sufficient size and capacity to store the materials and protect them from the effects of weather.

Valves shall be stored under cover until being required for installation, care being taken to protect any mechanical parts and accessories. Pipes and fittings in storage shall be laid on timber bearers so as to at least 75 mm above the ground. Care shall be taken not to damage any protective coatings or paint work. Straight pipes shall not be stacked more than three meters high without the approval of the Purchaser. Fittings and valves shall not be stacked.

Upon completion of the works, the Supplier shall collect from the Site any surplus pipes, fittings and valves which have been provided.

1.3 Inspection

All pipes and fittings to be supplied under the Contract shall be inspected by the PURCHASER at the Supplier's premises or at the places of manufacture if manufactured at other premises.

The Supplier shall provide such office facilities, assistance, labour, materials, electricity supply, fuel, stores, apparatus and instruments ultrasonic thickness indicators and high voltage

holiday detectors as may be necessary to allow a thorough and extensive inspection to be carried out.

The PURCHASER shall be entitled at all times during manufacture to inspect, examine and test on the Supplier's premises or at the places of manufacture if manufactured at other premises, the materials and workmanship of the pipes and fittings. Such inspection, examination or testing including the inspection by the PURCHASER shall not relieve the Supplier from any of his obligations under the Contract.

1.4 Markings of Pipes and Fittings

Each standard length of pipe, pipe specials and truly circular pipes shall have the following information painted outside: -

- The word S.I.T.E (50mm high) in capital letter
- The diameter, length and consecutive number and Bill of Quantities item number.
- The weight in kilogram.
- The item number and its consecutive number if more than one in the item
- Diameter of branch in the case of tees and angle in the case of bends and angle branches.

Truly circular pipes shall be marked with two longitudinal parallel bands throughout their whole length.

The diameter and its consecutive number of standard-length pipes shall be repeated on the lining just inside on both ends of the pipes.

The item number and diameter of branch in the case of tees and the angle in degrees in case of bends shall similarly be repeated on the lining.

1.5 Quantities of Goods

The quantities set out in the Price Schedule are provisional only and they are not to be taken as the actual, limiting and correct quantities of the pipes and fittings to be supplied by the Supplier in fulfillment of his obligations under the Contract. For the purpose of this clause, pipes shall be measured and paid in effective length. The effective length shall mean the net length of the pipe as laid, i.e. after deduction of the length of overlap at any spigot and socket joint to be made with the pipe. Plain ended pipes shall be measured and paid by the gross length and pipe specials shall be measured by numbers. All pipes and specials shall only be measured for payment after they have been laid, tested, accepted and incorporated in the works. Any excess pipes and specials supplied to the Site shall not be measured for payment.

The cost of all works testing and all other requirements of the Specification including lining, coating, wrapping, etc, involved in the manufacture and delivery of the HDPE pipes shall be deemed to be included in the Contract Rates.

2 HDPE Pipes and Specials

2.1 Definition

The following terms shall have the meanings hereby assigned to them except where the context clearly renders these meanings inapplicable.

“Pipes” means straight pipes, whether whole or in cut lengths.

“Fittings or pipe specials” means tees, bends, tapers, collars, flange adapters, blank flanges, expansion joints, mechanical joints, ring girders and similar accessories.

2.2 Standards and Codes of Practice

The following Standards and Codes of Practice are referred to in this section of the Specification. The Standard or Codes shall be the latest edition current at the time of its preparation unless otherwise specified for particular application.

DIN & PS Standards

- PS 3580 Polyethylene pipes for water supply
- DIN 8074 Polyethylene (PE) - Pipes PE 80, PE 100 - Dimensions
- DIN 8075 Polyethylene (PE) pipes - PE 80, PE 100 -Testing

ANSI/AWWA

- ANSI/AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76 mm) for Water Service
- ANSI/AWWA C906 Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission
- ANSI/AWWA C651 Standard for Disinfecting Water Mains • AWWA M55 Manual of Water Supply Practices, PE Pipe–Design and Installation

Plastics Pipe Institute, PPI

- PPI Handbook of Polyethylene Pipe – 2009 (2ndEdition)
- PPI Municipal Advisory Board (MAB) Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe
- PPI Material Handling Guide for HDPE Pipe and Fittings • PPI TR-33 Generic Butt Fusion Joining Procedure for Polyethylene Gas Pipe
- PPI TR-34 Disinfection of Newly Constructed Polyethylene Water Mains • PPI TR-38 Bolt Torque for Polyethylene Flanged Joints

- PPI TN-42 Recommended Minimum Training Guidelines for PE Pipe Butt Fusion Joining Operators for Municipal and Industrial Project
- PPI TR-46 Guidelines for Use of Mini-Horizontal Directional Drilling for Placement of High-Density Polyethylene Pipe

ASTM

- ASTM F 585 Standard Guide for Insertion of Flexible Polyethylene Pipe into Existing Sewers
- ASTM F 714 Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
- ASTM F 905 Standard Practice for Qualification of Polyethylene Saddle-Fused Joints
- ASTM F 1055 Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and ASTM F 1290 Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
- ASTM F 1962 Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit under Obstacles, Including River Crossings
- ASTM F 2164 Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
- ASTM F2206 Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock
- ASTM D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
- ASTM F 2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings ASTM D 2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
- ASTM D 2737 Standard Specification for Polyethylene (PE) Plastic Tubing • ASTM D 2774 Standard Practice for Underground Installation of Thermoplastic Pressure Piping
- ASTM F 2880 Standard Specification for Lap-Joint Type Flange Adapters for Polyethylene Pressure Pipe in Nominal Pipe Sizes 3/4 in. to 65 in.
- ASTM F 3124 Standard Practice for Data Recording the Procedure Used to Produce Heat Butt Fusion Joints
- ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
- ASTM D 3035 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
- ASTM D 3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

2.3 Submissions

The Supplier shall provide drawings, calculations and data in respect of the following product data to the Purchaser for review for all pipe and appurtenances.

- Furnish in duplicate to the Purchaser confirmation that product shipped meets or exceeds the standards set forth in the price schedule and this specification. This shall be in the form of a written document from the manufacturer attesting to the manufacturing process meeting the standards.
- Provide a statement that personnel responsible for fusing the pipe have been trained and qualified.

Supplier shall also submit the following to the Purchaser for approval:

- Certified dimensional as-built drawings/profile of all pipe, specials and fittings.
- Details of fittings and specials such as elbows, wyes, tees, outlets, connections, test bulkheads, bosses and nozzles or other specials where shown on the Construction Drawings, which indicate amount and position of reinforcement. All fittings and specials shall be properly reinforced to withstand the internal pressure both circumferential and longitudinal, and the external loading conditions as indicated in the Contract Documents. Shop Drawings shall clearly detail all pertinent dimensions

2.4 PRODUCTS

2.4.1 HIGH DENSITY POLYETHYLENE MATERIALS

A. Resin and Material Requirements

1. All material shall be manufactured from a PE 4710 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material shall meet the specifications of ASTM D 3350 with a minimum cell classification of 445474C. HDPE pipe and fittings shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. HDPE products shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, voids, or other injurious defects.

B. HDPE Pipe

1. Pipe shall be made of HDPE material with a minimum material designation code of PE4710 and with a minimum Cell Classification as noted in 2.01.A. The polyethylene compound shall be suitably protected against degradation by ultraviolet light by means of carbon black content of not less than 2 percent. The manufacture of the HDPE resin shall certify the cell classification indicated.

2. Pipe sizes 3" and large shall have a manufacturing standard of ASTM F 714, while pipe smaller than 3" shall be manufactured to the dimensional requirements listed in ASTM D 3035. Dimension Ratio (DR) and Outside Diameter (IPS/DIPS) shall be as specified on plans.
2. Pipe shall meet AWWA C901 (1/2" to 3") or AWWA C906 (4" to 63"), and shall be listed as meeting NSF-61.
3. Pipe shall also meet the requirements of Din 8074, Din 8075 and PS 3580.
4. When required by the owner, pipe shall be color coded for the intended service. The color coding shall be permanently co-extruded stripes on the pipe outside surface as part of the pipe's manufacturing process. Color coding shall be as follows:
 - a. Sewer – green
 - b. Water – blue
 - c. Reclaim – purple

C. HDPE Fittings

1. Butt Fusion Fittings- Fittings shall be made of HDPE material with a minimum material designation code of PE4710 and with a minimum Cell Classification as noted in 2.01.A. Fittings shall have a minimum pressure rating equal to or greater than the pipe to which they are joined unless otherwise specified on the plans or accepted by owner/Purchaser. All fittings shall meet the requirements of AWWA C901 or C906.
 - a. Molded fittings shall comply with the requirements of ASTM D 3261.
 - b. All fabricated elbows, tees, reducing tees and end caps shall be produced and meet the requirements of ASTM F 2206, as manufactured by ISCO Industries, Inc or other approved manufacturer holding an ISO 9001 quality system certificate. Each fitting will be marked per ASTM F 2206 section 10 including the nominal size and fitting EDR, which will meet or exceed the pipe DR identified for the project. Fabricated fittings shall be manufactured using a McElroy DataLogger to record fusion pressure and temperature, and shall be stamped with unique joint number that corresponds to the joint report. A graphic representation of the temperature and pressure data for all fusion joints made producing fittings shall be maintained for a minimum of 5 years as part of the quality control and will be available upon request of owner. Test results to validate ASTM F 2206 section 7.3 and 9 shall be provided to owner or owner's representative upon request.
 - c. Socket fittings shall meet ASTM D 2683.
2. Electrofusion Fittings - Fittings shall be made of HDPE material with a minimum material designation code of PE 4710 and with a minimum Cell Classification as noted in

2.01.A. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a minimum pressure rating equal to or greater than the pipe to which they are joined unless otherwise specified on the plans. For potable water systems, all electrofusion fittings shall have AWWA approval.

3. Bolted Connections- Flanges and MJ Adapters shall be fused onto the pipe and have a minimum pressure rating equal to or greater than the pipe unless otherwise specified on the plans.
 - a. Metallic back-up rings (Van-Stone style lap joint flanges), shall have a radius on the inside diameter of the bore so as to be compatible with HDPE Flanges. Back up rings shall have bolt pattern that will mate with AWWA C207 Class D (generically known as 150-pound patterns).
 - b. Where shown on the drawings, 4" and larger transitions to mechanical joint fittings and valves shall be accomplished using a MJ Adapter with kit. The D.I./HDPE mechanical joint adaptor shall consist of an HDPE mechanical joint transition fitting, rubber gasket, a mechanical joint backup drive ring, and Corten mechanical joint tee bolts
4. Mechanical Fittings: The use of mechanical coupling and saddles shall be approved by the owner or Purchaser prior to installation. Mechanical Fittings shall be designed for use and compatible with HDPE pipe, including SS stiffeners when required by manufacturer. Mechanical fittings shall have a pressure rating equal to or greater than the pipe

D. Fusion Equipment Requirements

1. Butt fusion equipment must be in satisfactory working order and the hydraulic system must be leak free. Heater plates shall be free from scrapes, gouges, and have a consistent clean coated surface. The pressure gage and thermometer should be checked for accuracy. When requested by the owner, records showing a maintenance service/inspection within 3 months prior to use for this project shall be provided.
2. Rental Fusion Equipment must be maintained by an Authorized Service and Repair Center.
3. Electrofusion Processors shall be maintained and calibrated per manufacturer's requirements and recommendations.

E. Approved Suppliers

1. All Pipe, Fittings, and Fusion Equipment shall be provided from an approved manufacturer as decided by the Purchaser.

2.4.2 PIPELINE LOCATING MATERIALS

- A. Detectable Marker Tape- Plastic marker tape shall be 5 mil minimum thickness with a solid aluminum core of 0.35mil minimum thickness and a minimum width of 2". The background of the tape shall be colored based on pipe service with black lettering continuously printed. Marker tape shall have a minimum 35 lbs./inch tensile strength. The installation of the tape shall be at 18 inches below finish grade.
- B. Tracer Wire- All HDPE pipe 4" and greater shall be installed with an extra high-strength, copper clad steel tracer wire including 45 mil HDPE jacket that has a minimum average break load of at least 1150 lbs. The jacket shall be colored based on pipe service, with blue for potable water or green for sewer. Tracer wire gauge shall be 12 AWG, 10 AWG, or 8 AWG depending upon application and installation procedure. This wire shall to be continuous and brought up in the valve boxes at the ends of each line segment with splices made only by methods per the equipment manufacturer's recommendation. All miscellaneous splicing components shall be furnished and installed by the Supplier.

3 EXECUTIONS

3.1 GENERAL

- A. All HDPE pipe and fittings shall be cut, joined, and installed in accordance with the manufacturer's recommendations. Joining, laying, and pulling of polyethylene pipe shall be accomplished by personnel experienced in working with polyethylene pipe systems.

3.2 TRANSPORTATION, UNLOADING, AND STORAGE

- A. The transportation carriers shall use appropriate methods and intermittent checks to ensure the pipe is properly supported, stacked and restrained during transportation such that the pipe is not nicked, gouged, or physically damaged. The transportation carrier shall provide tarpaulins to cover any potable water pipe subject to exposure to diesel exhaust or smoke.
- B. During loading, transportation, and unloading, every precaution should be taken to prevent damage to the pipe.
- C. Pipe shall not be stacked higher than the limits recommended by the manufacturer. The bottom tiers shall be kept off the ground on timbers, rails, or concrete. Pipe shall not be stored close to heat sources.
- C. The open ends of all sections of joined and/or installed pipe (not in service) shall be plugged to prevent animals or foreign material from entering the pipe line. All sealing surfaces of mating components (i.e., flange faces) shall be kept free from dirt or debris at all times

3.3 PIPE INSPECTION

- A. All pipe and fittings shall be subjected to visual inspection at time of delivery and before they are installed or lowered into the trench to be laid. Defective, damaged, or unsound pipe will be rejected. Cuts, punctures, or gouges that penetrate or reduce the wall thickness by 10% or more are not acceptable and must be removed and discarded.

3.4 HANDLING PIPE

- A. The handling of the pipeline shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. Sections of the pipes with cuts and gouges exceeding 10 percent of the pipe wall thickness or kinked sections shall be removed and the ends rejoined.
- B. Refer to the PPI Material Handling Guide for HDPE Pipe and Fittings for recommendations, guidelines and instructions regarding the handling, lifting, loading, storing and installing polyethylene pipe and fittings.

3.5 PIPE JOINING AND INSTALLATION

A. Direct Burial

- 1. Buried HDPE pipe and fittings shall be installed in accordance with ASTM D 2321 or ASTM D 2774 for pressure systems and AWWA Manual of Practice M55 Chapter 8. The Design Window identified in AWWA M55 Chapter 5 (page 65 of 2006 version) shall be considered acceptable design and installation conditions.
- 2. Unless required by the owner's Purchaser, no thrust blocks shall be placed in the HDPE pipe system since the fused system is fully restrained.

B. Trenchless Installation Methods

- 1. Installation of HDPE Pipe by Directional Boring shall follow the guidelines for ASTM F 1962 or PPI TR-46.
- 2. Installation of HDPE Pipe by slip lining shall follow the guidelines outlined in ASTM F 585.
- 2. Installation of HDPE Pipe by pipe bursting shall be performed by a company who is a member of the International Pipe Bursting Association (IPBA) and shall offer an installation plan that meets the IPBA Guidelines for Pipe Bursting

C. Fusion Joining Requirements

1. All HDPE pipe shall be joined to itself by the heat fusion process which produces homogeneous, seal, leak tight joints. Tie-ins between sections of HDPE pipe shall be made by butt fusion whenever possible.
2. Butt Fusion: The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620 or PPI TR-33. A record or certificate of training for the fusion operator must be provided that documents training to the fundamentals of ASTM F 2620. Considerations should be given to and provisions made for adverse weather conditions, such as temperatures below freezing, precipitation, or wind, which is accepted by the owner/Purchaser.
3. Electrofusion: Electrofusion joining shall be done in accordance with the manufacturers recommended procedure. Other sources of electrofusion joining information are ASTM F 1290, PPI TN 34, and PPI Municipal Advisory Board (MAB) Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe. The electrofusion processor must be capable of reading and storing the input parameters and the fusion results for later download to a record file. Qualification of the fusion technician shall be demonstrated by evidence electrofusion training within the past year on the equipment to be utilized for this project.

D. Fusion Operators

1. The employer of the fusion machine operator is responsible for the fusion joint quality of the fusion weld made by that individual. The employer is responsible for documenting all qualification and training records of that individual.
2. All HDPE fusion equipment operators shall be qualified to the procedure used to perform pipe joining. Fusion equipment operators shall have current, formal training on all fusion equipment employed on the project. Training received more than two years prior to operation with no evidence of activity within the past 6 months shall not be considered current.
3. For Projects with at least 5,000 feet or with pipe larger than 24 inches, operators or their supervisor must have a current Fusion Training Certificate for the equipment to be used on the project.

E. Butt Fusion Equipment:

1. For 6" and larger pipe sizes, the pipe butt fusion machine shall be a hydraulic fusion machine capable of butt fusing HDPE pipe. The carriage must be removable from the chassis for in-ditch use. The machine must be compatible with an electronic data recording device, Data Logger or equal. Accessories will include all butt fusion inserts

for the specified range of pipe sizes, a pyrometer kit for checking the surface temperature of the heater, extension cord (25' minimum), and hydraulic extension hoses (minimum of four). The butt fusion machine will be approved by the supplier/ manufacturer.

3.6 FLUSHING, CLEANING, AND DISINFECTING

A. All mains shall be cleaned and flushed to remove all foreign matter.

B. Disinfection:

1. Cleaning and disinfecting of potable water systems shall be in accordance with AWWA C651 and AWWA Manual of Practice M55 Chapter 9, and PPI Handbook of Polyethylene Pipe Chapter 2 (2nd Edition). The disinfection chemicals should be limited to less than 12% active chlorine. The duration of the disinfection should not exceed 24 hours. Upon completion, the system should be thoroughly flushed with fresh water, and sampled to verify the disinfectant chlorine level has been reduced to potable drinking water concentrations in all service water tubing and branch lateral pipes.

3.7 TESTING AND LEAKAGE

- A. The Supplier shall restrain pipe, components, and test equipment as required to ensure testing can be accomplished in a safe manner, including protection of personnel, equipment, and public in the event of a failure during testing.
- B. Pressure Pipelines-Pressure testing shall be conducted in accordance with requirements and recommendations of ASTM F 2164 (Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure), AWWA Manual of Practice M55 Chapter 9, and PPI Handbook of Polyethylene Pipe Chapter 2 (2nd Edition). Pneumatic (compressed air) leakage testing of HDPE pressure piping is prohibited for safety reasons.
1. The section of pipe to be tested shall be filled with potable or generally clean water (uncontaminated river/lake water) approved by the Owner/Purchaser. While the system is being filled with water, air shall be carefully and completely exhausted. If permanent air vents are not located at all high points, the Supplier shall install fittings and valves at such points so the air can be expelled as the pipe system is slowly filled with water.
 2. If the Supplier elects to perform hydrostatic testing against valves in an existing distribution system, it does so at his own risk and will bear the cost of any damages to the existing valve, piping system, private or public property, or the new pipeline under test.
 3. The test procedure for HDPE pipe consists of two steps: 1) the initial phase or expansion phase and 2) the test phase. During the initial/expansion phase, sufficient make-up water shall be added hourly for 3 hours to return to the test pressure. During the test phase, the

expansion phase pressure is reduced by 10 psi to test phase pressure and monitored for at least one hour (3 hours maximum).

4. Under no circumstances shall the total time under test exceed eight (8) hours. If the test is not completed due to leakage, equipment failure or any other reason, depressurize the test section and permit the system to "relax" for eight (8) hours prior to the next testing sequence.
5. The test pressure should be related to the lowest point in elevation along the test section's vertical pipeline profile.
6. The test pressure shall be 1.5 times the operating pressure at the lowest point in the system. In accordance with section 9.8 of ASTM F 2164, the pipe shall pass if the final pressure is within 5% of the test phase pressure for the testing period (3 hours maximum). If the test section fails this test, the Supplier shall repair or replace all defective materials and/or workmanship at no additional cost to the Purchaser.

3.8 Records

The Supplier shall keep full and detailed records including item numbers, size of each, and location of all pipes and specials which are:

- delivered to Site
- declared to be defective
- used in the Works
- cut, broken or removed from Site

The Supplier shall keep such records continuously up to date, and shall have them available for inspection by the PURCHASER at any reasonable time.

3.9 Valve Chambers

The operation of all valves including scour and air valves shall be checked by the Supplier and any necessary adjustments made to ensure correct operation. Valve chambers shall be constructed by the Contractor for Civil Works.

The Supplier shall first obtain from the manufacturers the minimum required size of the chambers. The Purchaser's approval shall be sought should there be any variation. The Supplier shall pay all subsequent costs due to any such variations.

Drainage from valve chambers to suitable outfalls shall be provided as directed by the PURCHASER.

4 Pipeline Appurtenances

4.1 General

The Supplier shall supply and install gate valve, sluice valve, non return valves, etc. at location as shown on drawings and directed by the Purchaser.

4.2 Gate Valves

Gate valves shall comply with BS 5150. All valves shall be suitable for use with potable water. Valves complying with BS 5163 are acceptable provided that they also comply with BS 5150.

Specific Clauses of BS 5150 are amplified as follows:

Clause 3 Type of Valves

Solid with non-rising main

Clause 4 Normal sizes

All valves shall be flanged end PN designated non-clamp type valves. Sizes as specified or indicated on the Drawings.

Clause 5 Normal Pressure

PN 16 unless otherwise specified or indicated on the Drawings, where a pressure in excess of PN 25 is specified, valves shall be constructed generally as above but modified as necessary for the higher-pressure rating.

Clause 8 General

Flanged and drilled to BS 4505.

Clause 8 Bypass

Valves DN 400 and over shall be fitted with integral bypasses.

Bypass valves and pipe sizes shall be:

DN 400 valve — DN 50 bypass

DN 450 to 600 valve — DN 80 bypass

DN 650 to 1000 valve — 100 DN bypass.

Clause 9 Body Tapping

As specified to BS 21 (ISOIR7) fitted with bronze or gunmetal plug.

Clause 14 Operation

The direction of operation shall be clockwise to close the valve

Hand wheels shall require a force not greater than 20 kg on the outer rim to operate with a balanced pressure across the valve.

Tee keys shall require a force not greater than 12 kg applied at the opposite ends of a standard key from the closed position.

Clause 15 Indicators

Indicators showing both open and shut positions shall be supplied and when specified, provisions shall be made for initiating the operation of remote indicator lights in the fully OPEN and CLOSED position.

Clause 16.17 Choice of Materials

Brass shall not contain more than 5% zinc gunmetal to BS 1400 Grade LG3; aluminum bronze or nickel copper alloy may be employed for internal components. Body and wedge shall be of spherical or cast grey iron.

Clause 19 test Certificates

The Supplier shall provide a Test Certificate confirming that the valves have been tested in accordance with BS 5150 and stating the actual pressures and medium used in the test. In addition, the Supplier shall ensure that the Purchaser has access to the manufacturer's works at all reasonable times for the purpose of inspecting the assembled valves and witness testing.

4.3 Gate Valves (High Pressure Type)

Gate valves shall be wedge type complying with BS 1414, Class 900. The pressure/temperature rating shall be in accordance with Table PE-1 of BS 1560: Part 2.

The wedge shall be plain solid wedge type. Shell materials shall be selected from those listed in Table PE-1 of BS 1560: Part 2

Trim materials, except the stem, shall be bronze to BS 1499 — LG2 as listed in Table 2 of BS 1414. The stem shall be stainless steel 18-8 Ti as listed in Table 2 of BS 1414.

Flanged ends shall be Class 900 raised face type complying with ANSI B 16.25 or Table PB-I of BS 1560: Part 2.

Butt welded ends shall be in accordance with Clause 8.7 of BS 1414. Operation shall be by hand wheel or square head and tee key as shown on the Drawings.

One body tapping shall be provided in the bottom of the valve in accordance with Clause 8.9 of BS 1414 for drainage. Tapping shall be provided with plugs. A valved by-pass shall be provided in accordance with Clause 17.2 of BS 1414. The materials of the by-pass shall be at least of the same standard as those specified for the main valve.

4.4 Check Valves (High Pressure Type)

Check valves shall be piston type horizontal flow valves complying with BS 1868, Class 900. They shall be designed for rapid closing, without slamming, on cessation of forward flow. The pressure/temperature rating shall be in accordance with Table PB-i in BS 1560: Part 2.

Shell materials shall be from those listed in Table PB-i of BS 1560: Part 2 and the trim material shall be bronze to BS 1400—L2 of BS 1868.

Flanged ends shall be Class 900, raised face type complying with ANSI B 16.25 or Table PE 1 of BS 1560: Part 2.

Butt welded ends shall be in accordance with Section 8 of BS 1868.

The valves shall be provided with an equaliser. One body tapping shall be provided in the bottom of the valve in accordance with Clause 8.10 of BS 1868 for drainage.

Tapping shall be provided with plugs.

4.5 Automatic Air Relief Valves (High Pressure Type)

Automatic air relief valves shall be designated to meet the following conditions:

- (a) Discharge air during charging of the pipeline
- (b) Admit air during emptying of the pipe
- (c) Discharge air accumulated at local peaks along the pipeline under normal operating conditions.

Conditions (a) and (b) shall be met by the employment of a large orifice capable of handling large volumes of air at a high flow rate, and condition (c) by a small orifice capable of discharging small quantities of air as they accumulate.

Valves with air intake or exhaust facilities shall have approved screening arrangements to prevent the ingress of air borne sand.

4.6 Types of Air Valves (High Pressure Type)

(i) Double Acting Air Valves

These shall combine both large and small orifices within one valve. The large orifice shall be sealed by a buoyant rigid ball and the chamber housing shall be designed to avoid premature closing of the valve by the air whilst being discharged. The small orifice shall be sealed by a buoyant ball at all pressures above atmospheric except when air accumulates in the valve chamber.

(ii) Single Air Valves

These include a small orifice only, operating in a manner identical with the small orifice in a double acting valve.

The nominal pressure rating shall be PN 100 or as indicated on Drawings.

Flanges shall be Class 900 raised face type complying with ANSI B 16.25 or Table PE-1 of BS 1560 Part 2.

The materials for the valves shall be as follows:

Body cover and cowl	-	Ductile iron
Small Orifice	-	Brass with Rubber seat
Small Orifice Ball	-	Rubber covered or stainless steel or other approved
Large Orifice	-	Brass with Rubber seat
Large Orifice Ball	-	Vulcanite covered or stainless steel or other approved.

4.7 Automatic Air Relief Valves (Low Pressure Type)

Shall be designed to meet the following conditions:

- (a) Discharge air during charging of the pipeline
- (b) Admit air during emptying of the pipeline
- (c) Discharge air accumulating at local peaks along the pipeline under normal operating conditions.

Conditions (a) and (b) shall be met by the employment of a large orifice capable of handling large

volumes of air at a high flow rate and condition (c) by a small orifice capable of discharging small quantities of air as they accumulate.

Valves with air intake or exhaust facilities shall have approved screening arrangements to prevent the ingress of air borne sand.

4.8 Types of Air Valves (Low Pressure Type)

(i) Double Acting Air Valves

These shall combine both large and small orifices within one valve. The large orifice shall be sealed by a buoyant rigid ball and the chamber housing shall be designed to avoid premature closing of the valve by the air whilst being discharged. The small orifice shall be sealed by a buoyant ball at all pressures above atmospheric except when air accumulates in the valve chamber.

(ii) Single Air Valves

These include a small orifice only, operating in a manner identical with the small orifice in a double acting valve.

The nominal pressure rating shall be PN 16 or as indicated on Drawings.

Body ends shall be flanged with raised faces and drilled to BS 4504 for the nominal pressure specified or indicated on the Drawings or shall be screwed 25 mm BSPTC male as indicated on the Drawings.

The materials for the valves shall be as follows:

Body cover and cowl	-	Cast iron
Small Orifice	-	Cast iron with gunmetal seat
Small Orifice	-	Ball Rubber covered or other approved
Large Orifice	-	Cast iron with rubber seat
Large Ball	-	Vulcanite covered or other approved

Each valve shall be provided with its own isolating gate valve or cock, which will permit the removal of the entire valve whilst the pipeline is 'live'.

Valves shall be factory finished with a two-pack epoxy paint system to the approval of the Purchaser.

TECHNICAL SPECIFICATIONS

PART III - SOLAR POWER SUPPLY SYSTEM

1. Scope of Work

The scope of work includes design, supply, installation, integration, testing and commissioning and initial maintenance of the Solar Power Supply (SPS) in accordance with the functional, technical and special provisions lay down herein. In case of conflict in the provisions herein with those present in the balance of the Bidding Documents, the requirement of the Price Schedules will take precedence. A typical baseline solution is described herein. Supplier may propose alternate solutions provided that they are better technically and economically. Supplier shall in this case provide adequate justifications. It may be noted that Supplier must provide the Schedule of Technical Data (STD) duly filled in for each of their proposed equipment.

2. VFD Unit with Power Conditioner DV/DT (for Source Pump)

The VFD (variable frequency drive) unit characteristics shall be compatible to characteristics of source submersible borehole pumps and shall be operable from solar power supply.

- The submersible motors used with VFD shall be of class F insulation with class B temperature rise or higher as per VFD requirement.
- Each VFD shall be equipped with swinging choke (factory installed and tested) capable of reducing total harmonics distortion by up to 25 % or alternatively 5 % impedance line reactor shall be installed ahead of each VFD to reduce the effects of current & voltage harmonics. The choke or line reactor in each VFD shall be sized such that it does not reduce the driving motor performance.
- Each VFD shall be provided with surge arrester in order to protect it against the surges created due to the abrupt changes in water flow or speed of the pump or systems voltages (Solar).
- The following codes & standards of latest editions shall be applicable: -
 - a) IEC 61800-3 Adjustable speed electrical power drive systems
 - b) IEC 61000 3-4 Harmonic mitigation for AC variable frequency pump drives
 - c) IEEE-519 Harmonic mitigation Hardware
 - d) IEC 60099 Surge arrestors

3. Solar Power Supply System (SPS)

Solar power systems shall be proposed for the operation of Tube well Pumps. These tube-well pumps shall be operational during the day time only.

The Solar pump system shall be installed to operate the onsite pump loads. The system shall have Off grid operation mode.

Pumps and PV modules shall meet the design constraints resulting in an efficient and economical system but still meeting the daily watering requirements. The system shall be designed to be efficient such as to minimize the system losses and capital expenditure without compromising on quality and performance of the proposed system.

3.1 System Configuration

Each pump can be powered by independent Solar system, driven by a MPPT Solar Variable Frequency Drive panel.

4. Design Considerations for Solar Power Supply

The following paragraphs lay down the design considerations for the solar power supply systems.

Supplier shall clearly explain the design, scheme of their system(s) and identify estimated system(s) output in watts and expected hours of operation per day for Pumps taking into consideration the total electrical demand (based on water requirement), load patterns, available solar insulation and other relevant factors.

Power supply ratings shall be determined on the basis of steady state load. As a safety factor, the capacity of the solar power supply system shall typically be (minimum) 30% higher than the connected load and shall be done in accordance with IEC 61727.

The scheme and the capacity of the solar power systems is left upon the Supplier's choice being the most knowledgeable on his specific solution for the tube well pumps. However, VFD based solar pump system(s) is to be proposed for this specific pump(s) load.

Following parameters shall be considered for the design of pump systems and shall be stated in the design report.

- Flow Rate/Daily Water Requirement (L/h).
- Type (Submersible).
- Total Dynamic Head (Static Lift + Static Head).
- Diameter of the pump.
- Mode of Operation (Solar).
- Efficiency.

Following parameters shall be considered for the design of pump systems and shall be stated in the design report.

- Total energy requirement to be generated per day
- System losses
- Mode of Operation (Solar).
- Efficiency.

In addition to the above, the Supplier's design will also consider provision of following documents (as a minimum) for Pumping:

- 1- Scheme of the proposed system
- 2- Capacity of System designed against given load.

- Total PV Array capacity
 - Rating of the proposed Inverter(s)
 - Average daily Output in kWh (yearly)
 - Footprint (area required) for the installation of PV Array
- 3- System design sheets with detailed steps incorporating different stages system losses computing the overall system capacity
 - 4- Monthly energy yield/ performance estimate sheets.
 - 5- Detailed description of Tool, methodology & procedures used to ensure accuracy & calibration of performance modeling, including but not limited to weather assumptions.
 - 6- Complete electrical and structural engineering services including labeled single line diagrams.
 - 7- System operation, safety manuals.
 - 8- Final PV system “as-built” schematics.
 - 9- Specification sheets of proposed equipment
 - 10- The performance assessment of installed systems will be carried out with respect to the provided energy yield estimates.

a) Energy Consumption of the Pumps

The estimated energy consumption per day for each tube well station is to be computed by the Supplier and will be submitted.

Solar Power Supply shall be designed with the consideration of the following important factors like equipment & system losses, Solar PV panel output power de-rating at NOTC, system design optimization and solar insulation on site.

b) Meteorological Analysis

A detailed Meteorological analysis shall be carried out to determine the amount of energy provided by the sun incident upon the solar panels. Multiple factors shall be considered including but not limited to: average sunny days, average sun duration / day, averaged carryover ambient temperature, extreme maximum/minimum recorded temperature, Carryover averaged precipitation and evaporation, Carryover averaged wind speed, carryover highest wind speed and occurrence time, prominent wind direction, clearness of the skies & latitude. Data on carryover and yearly monthly radiation incident, and data on the radiation incident (direct radiation, diffuse radiation and total radiation).

Based on above data specific to the site, a monthly insolation shall be computed for the site which should correlate with any of the internationally recognized irradiance data bases e.g. Meteonorm, NASA etc. This calculation shall encompass the change in sunlight due to cloudy or partially cloudy days.

Other parameters and their effect on system sizing shall also be considered. Monthly and yearly variations of these factors shall be considered to ensure sufficient output of the Solar Power Systems under the worst conditions. All calculations shall be put up for vetting by the Purchaser in the Supplier’s design report.

c) System Sizing

The size of the Solar Power System shall depend upon the amount of power that is required (watts), the amount of time it is to be used (hours), and the amount of energy available from the sun in a particular area (sun-hours per day). Supplier shall state the rating (watts) of their solar power systems and the estimated energy yield after incorporating losses. The rating shall commensurate as a minimum the electrical load of the filtration plant site plus a safety factor of 30%. The system losses must clearly be indicated during the detail design process. Supplier shall provide detailed design calculations showing that the SPS has sufficient capacity to power the water pump. All factors for the optimization of system design are to be considered.

d) Location and Orientation of PVPs (Photo Voltaic Panels)

A survey will be undertaken by the Supplier to identify the location and orientation adequate for placing the solar panels. The survey shall identify the cable routes and lengths. Solar panels shall be placed in an area that receives maximum sunlight and can securely support the PV panels. The area should preferably be clear of tall trees and foliage that could obstruct the exposure of the Panels to the sun. The shadows from trees, neighboring building or other structures shall also be considered such that the entire lot of PV Panels once installed shall not be subject to shadows at all times of the day throughout the year.

e) PVP Footprint (Area Determination)

Sufficient space has to be allocated at site for the installation of PV Array. The scheme of mounting structure is to be proposed by the Supplier. Panels can be ground mounted or pole mounted as the roof space won't be sufficient enough for the entire PV Array installation.

In order to highlight the best possible area for Solar array installation at site, detailed shadow analysis of the proposed site(s) must be carried out using relevant softwares to study variable sun paths & subsequent shadow projections on different times of the day, throughout the year.

This best-case scenario will act as an upper bound on the size of the system that could be installed. The final placement and distribution of the PV Array installation shall be reflected on a CAD drawing created using the set of plans and the measurements taken at site.

5. Technical Description and System Components

The Solar Power System (s) consists of the basic components;

- PV modules,
- Solar Pump Inverters (including MPPT & VFD feature)
- Cables
- Grounding equipment
- Instrumentation
- Mounting structures.
- Protection equipment shall include AC/DC circuit breakers/ switches.

The system shall be designed considerations above and the functional description herein.

Supplier shall provide specifications of his proposed solution in the Schedule of Technical Data.

a) Solar Photovoltaic Panels (PV modules) – General Characteristics

The specifications of modules are mentioned in Schedule of Technical Data (STD).

The following design factors need to be detailed in:

- Bills of Materials, BoMs: (glass, encapsulant, back sheet, ribbon, adhesives, cable, Junction box, connector).
- Type of cells comprising the module
- Specify number of modules and total power to be provided
- Maximum rated power
- Rated power tolerance
- Cell efficiency
- Module efficiency
- Power conversion efficiency at STC
- Voltage at the maximum power point, V_{mp}
- Current at the maximum current point, I_{sc}
- Open-circuit voltage, V_{oc}
- Short-circuit current, I_{sc}
- Maximum system voltage
- Temperature coefficient of short-circuit current
- Temperature coefficient of open-circuit voltage
- Temperature coefficient of maximum power $< -0.40\% / ^\circ C$
- Minimum efficiency at 200,600 & 800 W/m² (25°, AM 1.5)
- Minimum efficiency at 200,600 & 800 W/m² (45°, AM 1.5)
- Relative Power Conversion Efficiency reduction and I-V curves for different light intensities & temperatures
- Materials and workmanship warranty of a minimum of 10 years
- Power warranty/performance guarantee of a minimum of 25 years: the power output should not fall below 90% within 10 years, and below 80% within 25 years; linear warranty is mandatory.
- Degradation Curve from Manufacturer
- Module designed to withstand PID.
- Manufacturers confirmation for the suitability of module for specific weather conditions and the high UV-radiation
- Use of integrated bypass diodes
- Fill factor
- Series fuse rating
- Connector type
- Cable length
- Cross-sectional view of the module materials
- Tolerance to wind (maximum load) impact
- Dimensions and weight
- Type of frame with weatherproof specifications
- Junction box degree of protection

- Manufacturers installation guidelines
- Provide guarantees and data sheets (to be transferred to Purchaser upon DDP)
- Modules per box and 40 feet container
- Application Class- A
- Safety Class II
- Fire rating C.

The following module standards must be met, as applicable to crystalline silicon:

- IEC 61215
- IEC 61730 Part I and II for safety qualification testing
- IEC 61701
- ISO 9001, ISO 14001
- MCS, CE,
- Application Class: A
- Other applicable standards.

The efficiency of the PV modules should be minimum 15 % and fill factor should be more than 70%. Modules with higher power output per unit area shall be preferred and should not be less than 250 Watts.

There shall be a Name Plate fixed inside the module which should include but not limited to:

- a) Name of the Manufacturer or Distinctive Logo.
- b) Model Number
- c) Serial Number
- d) Year of manufacture

Moreover, Provide the I-V curves at different irradiance & temperature levels.

The PV modules shall be warranted for output wattage, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years.

Panels shall be of Mono/Poly crystalline silicon (Si) cells, protected by anti-reflective glass and by a special synthetic material. The number of panels to be used in a system shall be determined by the voltage current and power ratings of the PV modules vis-a-vis the plant and respective pump electrical power requirements.

The sizing calculations to determine the number of modules, number of strings and number of arrays shall be calculated by the Supplier on the basis of design parameters, functional characteristics and the Schedule of Technical Data (STD).

Basic mechanical characteristics, such as dimensions, frame profile, and static load rating, as well as grounding and mounting locations shall be considered while designing the system.

The Solar Panels must be of renowned brand. Solar panels shall have framed module with type a junction box (rain tight) accepting PG 13.5 conduit/cable fitting.

Mounting Structure

Hot dip galvanized, mechanically robust, iron mounting structures shall be provided for mounting the modules/panels/arrays. These mounting structures shall be used to mount the modules/panels/arrays

on the ground or roof tops at an angle of tilt with the horizontal in accordance with the altitude of the place of installation. Supplier shall state the angle of tilt in his detailed design report computed on the basis of yearly optimum yield.

- The solar array shall be supported by galvanized steel pillars with concrete foundations and shall be at suitable height from the ground level.
- They shall be designed for maximum durability and corrosive resistance in all environments.
- The mounting structure should be able to withstand wind speed of 160 km/ hr.
- Moreover, there should be adequate gap between modules to ensure withstand capacity of the complete structure.

The make, type and main features of SPSs shall be in compliance with the requirements of the STD (Schedule of Technical Data) & is to be duly filled accordingly.

b) Solar Pump System Components

I. Solar Pump Inverter:

The solar inverter(s)/ Variable frequency drive(s) with Inbuilt MPPT (Maximum Power Point Tracking) shall be provided for voltage conversion and regulation of the varying amounts of DC voltages and currents generated by the solar modules. A special purpose Solar Pump inverter is to be proposed which has inbuilt MPPT feature. Solar inverter capacity shall be determined in accordance with the parameters specified and quantified in the Schedule of Technical Data (STD).

The product should have the features listed below but not limited to:

- Maximum Power Point Tracking (MPPT).
- Pure Sine wave
- Instantaneous output status display (Speed / Power /Amps) etc.
- Data logging
- Display and Metering
- Automatic Start and Stop with Solar radiation
- Self-diagnostic and self-Protection
- Dry run protection
- The inverter shall be capable to operate in Off Grid and also Grid connected mode.
- The inverter shall be of single/three phase type (configurable)
- Output voltage Filter
- Automatic Power source switching against configurable set point (Solar & Grid)
- Configurable Power source priority
- The inverter shall support multi-string input with string failure detection.
- Grid monitoring.
- Environmental protection rating / electrical connection area shall be IP65.

Maximum Power Point Tracking (MPPT) solar invertors shall be provided so as to optimize the voltage of the PV array to maximize PVP power & to optimize the hours of operation.

The variations caused by temperature (*NOCT*) and type of module used shall be considered while defining the typical control set points (the voltages at which the controller changes the charge rate) or output power.

The pump inverter shall contain (but not limited to) following protections features:

- Reverse Current Blocking.
- Overcharge Protection.
- Low Voltage Disconnect (LVD).
- Overload Protection.
- Under/Over Voltage & Over Current protection
- AC short circuit protection.
- Ground fault monitoring.

It shall be preferred to design a higher voltage system which will result in less current, reducing the gauge of the system wiring. The output of the PV Array of SPS should conform with the input of the Solar Pump inverter ensuring product compatibility. The inverter shall be certified by an independent testing laboratory.

Power capacity of the inverter including Continuous, Limited-Time and Stack rating shall be clearly stated. Detail specifications including important values like Total Harmonic Distortion (THD), RMS (Root Mean Square) Voltage and Peak Voltage (VIP) regulation shall be according to the STD.

The peak efficiency of the inverter should not be less than two thirds of its capacity.

c) Installation Cables/Wires

- Installation including wiring shall meet the requirements and recommendations given in 8.3 of IEC 62124 ed 1. IEC 61000 / EN 501-78.
- The commissioning and acceptance will be subject to the fulfilment of all requirements specified in the above-mentioned paragraphs of IEC 62124 ed.1 and additional requirements as detailed below.
- Stranded and flexible insulated copper wires and cables must be used for all outdoor and indoor installations. Indoor installation of the lighting distribution system might be performed with solid wires, if appropriate and common practice.
- The wiring that leads into the building shall be protected in a conduit.
- External cables should be specifically adapted to outdoor exposure (see IEC 60811). Especially the outer insulation must be sunlight (UV)-resistant, weatherproof and designed for underground installation. Preferably rubber- coated and PE-coated cables shall be used.
- The temperature resistance of all interconnecting wires and cables should be $> 75^{\circ}\text{C}$. All wiring must be sized to keep line voltage losses to less than 3% between PV generator and Variable frequency drive for pump systems, battery (for battery backed system), less than 1% between battery and charge regulator, and less than 3% between battery and load, all of them at the maximum current conditions. The minimum cross-section must also allow the circuit to operate within the Amp capacity rating of the wire.
- Earth conductors, either separate or as a third wire in 3-core cables, if 'present, must be green-yellow.
- All exposed wiring must be in UV-resistant conduits or be firmly fastened to the building and/or support structure. Cable binders, clamps and other fixing material must also be UV-resistant, preferably made of polyethylene.
- Wiring through roofing, walls and other structures must be protected through the use of bushings. Wiring through roofing must be sealed (waterproof).
- Holes through roofing materials should be avoided wherever possible. Cables through roofing shall be contained in purpose-made roof-entry boxes, or proper UV-resistant

glands, which shall form a weatherproof seal to prevent leakages. In corrugated roofs, holes for cables are to be drilled at the top of corrugations. All holes in roofing shall be thoroughly sealed and made waterproof with UV-resistant silicone sealant or an equivalent method.

- Fittings need to be fastened to suitable supports, which may need to be provided if not already present. No conduit or fitting shall be attached directly to thatch or any other non-supportive surface.
- Holes that penetrate external walls shall slope slightly upward to prevent the ingress of water and be suitably sealed.
- Cables must be joined by the use of junction boxes, screw-connectors, block-connectors. All stranded wires must be terminated with proper end-sleeves. Soldering in the field and the use of wire nuts are not allowed. The rated current-carrying capacity of each joint must not be less than the circuit current rating.
- Junction boxes or enclosures must be dust- and waterproof, non-corrosive and electrically insulated (no metal boxes). Interior junction boxes shall have an IP protection of at least IP 32, and external junction boxes a minimum of IP 55 according to IEC 60529.
- Careful attention shall be given to entries into enclosures and junction boxes, to provide good sealing, proper strain relief to ensure that the wiring connections themselves are not under tension and to prevent chafing and damage to the insulation.
- Surface-mounted cabling shall be installed using appropriate fasteners at suitable intervals (15 to 20 cm) to prevent sagging.
- Visible interior cabling or conduits shall be aesthetically tidy, and should not slant from the vertical or horizontal unless essential.
- Suspended cables shall be mounted so that the lowest point is at least 2.8 m above ground level. The cable shall be held in position by suitable brackets and strain relief to prevent mechanical wear and any strain on the electrical connections.
- Mains (230VAC) sockets and plugs are not to be used under any circumstances. Any 12 V appliances with a mains-type plug attached constitute an unacceptable safety risk to the user if the appliance is used in a 230 VAC outlet.
- A product of good quality standard material to be provided, according to the given specification and good engineering practices.
- The flexible PVC conduit should be of good quality material with minimum ½ inch size.
- A wiring for solar connected load should be separate and independent in all aspects.
- Stranded and flexible insulated copper DC wires and cables must be used for all outdoor and indoor installations.
- The cables are selected such that the voltage drop must not exceed 1 % on DC side of the power inverter and 2.5 % on AC side of the power inverter. The calculation on the basis of which cable sizes shall be selected will be submitted.
- Single line diagram of the wiring scheme shall be submitted with the detailed proposal.
- The wiring that leads into the pole shall be protected in a PVC Spiral / Flexible conduit.
- External cables should be specifically adapted to outdoor exposure as per IEC 60811. The outer insulation shall be sunlight (UV)-resistant and weather-proof.
- All wiring should be colour coded.

- All exposed wiring must be in UV-resistant conduits and firmly fastened to the support structure. Cable binders, clamps and other fixing material must also be UV-resistant. All underground cabling shall be done in metal conduits.

d) DC Cables

The main design specification is to reduce Ohmic losses, without adversely affecting the cost trade-off, to < 1% at full power (under STC conditions 1000 W/m 2,25°C module temperature). Design calculations through cable loss simulation to be provided in the design report for review & comment. The Supplier shall firmly specify manufacturer, types and number of cables to be installed.

The following design factors need to be detailed by the Supplier:

- String cable shall be of the following type: single conductor type, copper, 1000 V / Class II (according to protection class II / 1000V, IEC 61140, single core cable, tinned copper conductor, XLPE Insulation, double EVA jacket (resistant to heat and cold, resistant to ozone, UV, oil and chemicals), Temperature: 90 ° C (Temperature Max. Allowable: 120 °C), Halogen free Connectors of Modules and string cables shall be connected of self-locking type, have IP65 rating and shall be from same manufacturer and type.
- The DC main (downstream of combiner box) wiring harness shall have the quality:
- Aluminium / Copper / 1000 V / Class II
- All cables shall be capable of accommodating all electric loads without overheating. Current carrying capacity certificate shall be provided to Employer for review and comments.
- Cables shall be suitable for the environmental conditions at the project site, including UV protection (certification from manufacturer to be provided by the Supplier)
- Balance of electrical potential shall be provided by the Supplier.
- Installation to be verified by measurement-protocols
- Technical documentation of DC-UV shall be provided by the Supplier.
- Clear and systematic labelling required

Standards:

- IEC 60228
- IEC 60364-1
- IEC 60754
- IEC 61034
- IEC 60811-2
- CSN-EN-ISO-4892
- IEC 60068:2011-12
- IEC 60228 (Cable losses)
- Other applicable standards.

e) DC Connectors

The following design factors shall be detailed in by the Supplier:

- High current rating

- Minimal contact resistance
- Convenient handling
- Broad compatibility
- Incompatibility with AC connectors to avoid mistakes during installation
- Force required to un lock connectors from cables, whether a tool is required for it or not.
- Double insulated for outdoor Installations.
- Suitable for Operation without de-rating upto 55°C.

Standards:

- EN 50521
- IEC 60512
- Other applicable standards

MC4 is effectively an industry staple for DC connectors, if not a standard, even though it is a proprietary design. If MC4 comparable connectors are used, a combination of different manufacturers are allowed. MC4 comparable connectors have to be certified.

6. FACTORY TESTS

PV Panels (PVP)

Supplier shall provide complete test reports listed herein from testing labs mentioned here in demonstrating that the PV modules being proposed have passed the following tests in accordance with the *latest IEC standards or the product fully complies with IEC 61215/61646*. Note that complete test reports showing test parameters, test equipment and test procedures are required.

Requirements of Type Tests and Test Reports to Qualify Acceptable Manufacturers

In case a Supplier is unable to provide type complete test reports from laboratories listed here above, then he shall arrange at his own cost to have the said tests be performed. The Purchaser and/or his representative shall in such a case witness the tests. All costs of testing and witnessing by the Purchaser and or his representative shall be deemed to be included in the contract price.

Life Expectancy Tests

Only those Solar PV modules shall be acceptable that have undergone Life Expectancy Tests (LETs) and full reports of the procedure and results of the LETs is provided. LETs shall be conducted as per ASTM E1171, UL1703. These comprise 1,000 hours of damp heat testing at 85 Deg C and 85% RH. 200 cycles of thermal cycle testing from -40°C to +85°C and back. Minimum dwell times of 10 minutes at -40 and + 85°C and maximum temperature transition rate of 100°C per Hour. i.e. 1.67°C per minute.

7. Guaranteed Performance Tests

Following tests shall be done to establish guaranteed performance parameters. These shall be done in accordance with IEC 61215 and IEC 61724 complete type test reports shall be provided by the Supplier:

- Visual Inspection Tests
- Maximum Power Determination Test
- Insulation Test
- Measurement of Temperature Coefficients
- Measurement of NOCT
- Performance at STC and NOCT
- Performance at Low Irradiance
- Outdoor Exposure Test
- Hot-Spot Endurance Test
- UV-preconditioning Test
- Thermal Cycling Test
- Humidity Freeze Test
- Damp Heat Test
- Robustness of Terminations
- Wet Leakage Test
- Mechanical Load Test
- Hail Impact Test
- Bypass Diode Thermal Test

Additionally, the Purchaser and/or his representative shall witness the following tests at the factory or place of production, on sampling basis on each lot of panels to be shipped. The test lot shall be 100 panels and sample size shall be five percent. The maximum allowable failure rate per lot shall be 5%. For failure rates exceeding the allowable limit the entire lot shall be rejected or tested on a 100% basis as directed by the Purchaser and/or his representative.

- Visual Inspection Tests
- Maximum Power Determination Test
- Insulation Test
- Measurement of NOCT
- Performance at STC and NOCT
- Performance at Low Irradiance
- Robustness of Terminations
- Bypass Diode Thermal Test

Testing Laboratories

All the test reports shall preferably be from the following independent laboratories.

- NREL USA
- TÜV
- CESI Italy
- Fraunhofer ISE Germany
- Intertek, UK
- Fraunhofer, Germany, U.S.A
- Florida Solar Energy Centre, U.S.A
- ScienLab Electronic Systems Germany (for Inverters Only)
- Korea Testing Laboratory, Korea (for Inverters Only)
- Japan Photovoltaic Expansion Center, Japan
- Renewable Energy Test Centre, U.S.A
- CFV (by CSA Group Canada, Fraunhofer USA, VDE Germany)
- VDE Institute, Germany
- CSA Group, (Canadian Standards Association), Canada.

Site Testing

Upon shipment and before installation, following tests shall be arranged and performed again at site before installation of modules in the presence of Purchaser and his representative personnel; selection of modules for these tests shall be in accordance with IEC standard (IEC 60410):

- Visual Inspection for major visual defects only
- Bypass Diode Thermal Test
- Wet Leakage Test
- Insulation Test
- Maximum Power Determination Test

8. TESTS ON COMPLETION OF INSTALLATION

The following tests as a minimum are required to be performed on the completion of installation.

Pre-Commissioning Tests

The pre-commissioning checks shall consist of the following (mandatory minimum):

- Information about Project
- Compliance with the system design
- General Inspection
- Compliance with relevant installation instructions/regulatory requirements
- PV Module Mounting Structure & Civil foundation
- DC Junction Box or String Monitoring Box
- Earthing & Lightning Arrestor
- PV Module
- Inverter
- AC Distribution Box
- Cable identification and cable routing inspection
- The provision of adequate ventilation for system components electrical safety
- Cable insulation test
- The security and integrity of system components
- Fuse continuity and string open circuit voltage test
- String DC short circuit current test
- Isolation device functional test
- Electrical over-current protection arrangements

Commissioning Tests

After completion of all visual inspections from the checklist, the service provider must perform commissioning tests to ensure all inter-connections of the components are satisfactory.

The commissioning tests comprise the following:

- PV module
- PV array
- Cable and wiring

- Inverter
- Array Junction Box/String Monitoring Box
- AC Distribution Box
- Weather Monitoring Station and PV Monitoring System
- Cable insulation test
- String fuse continuity & String Open circuit voltage test
- Isolation device functional test
- Inverter functional test
- DC Current test

Trial Run

Upon successful completion of testing and commissioning, the reliability of the system shall be tested using Performance Ratio (PR) test

During the Performance Ratio (PR) test, the following real time parameters must be sampled at one-minute intervals for at least seven consecutive days:

- Solar irradiance
- Ambient temperature
- Module temperature
- Wind speed
- DC voltage of each string
- DC current of each string
- AC voltage from each inverter
- AC current from each inverter

Following in-factory tests shall be witnessed by the Purchaser and/or his representative. Applicable standard G 59/2 BS EN 61000-3-3.

- Harmonic current emissions
- Voltage fluctuations and flicker
- Power factor
- DC Injection
- Under/over Frequency tests
- Under over voltage tests
- Loss of mains test
- Reconnection times

Following standards as a minimum:

EN 62109-1 2010 (Safety)

EN 61000-6-2:2005 (EMC compatibility)

TECHNICAL SPECIFICATIONS

PART IV – PUMPING EQUIPMENT AT PUMP HOUSE

1. Works to be Included

The works to be included in this section shall comprise the design, manufacture, works witness testing, delivery, storage, installation, site testing and commissioning and maintenance of: -

- a) Submersible borehole pumping units having VFD features shall be selected for operation on solar energy system Piping, Fittings and Allied Works.

2. Reference Standards

ASTM - A 27	Standard Specification for Steel Castings, Carbon, for General Application
ASTM - A 210	Heat Resisting Chromium and Chromium - Nickel Stainless Steel Plates
ASTM - A 276	Standard Specification for Stainless Steel Bars and Shapes
ANSI/ HI 11.6	Submersible Pump Tests
ASTM - A 743	Castings, Iron - Chromium, Iron – Chromium - Nickel, Corrosion Resistant, for General Application
ASTM- A 213	Alloy-Steel and Stainless-Steel Bolting for High Temperature or High Pressure Service
ASTM- A 214	Specification for Carbon and Alloy Steel Nuts & Bolts for High Pressure Or High Temperature Service

3. Brief Description of works

5 No Submersible pumps to be installed at pumping station in different villages having discharge of 200 gpm and dynamic head of about 120m and capacity 30 HP or as per field requirement.

- A. The pumps shall be designed, installed and tested in accordance with applicable requirements of ASTM and Hydraulic Institute Standards.
- B. The Supplier shall check the design functions of each equipment; analyse system pressure loss, hydraulic transients for normal and emergency conditions at minimum and maximum flow.
- C. Each equipment shall be suitable for rendering intended functions individually as well as part of the system under the Project's climatic and environmental conditions.
- D. The pump driver preferably shall have VFD features considering the minimum & maximum speed as well as torque requirements.
- E. Pump shall be Anti-thrust bearings along with journal bearings. shall be used in submersible borehole pumps.

4. Pump Requirements

The Supplier shall carefully select the pumps to ensure that have a stable characteristic under all suction heads and shall operate with high efficiency.

5. Submittals for Pumping Units

- A. Shop drawings: Indicate general assembly, components, dimensions, weights, clearances and methods of assembly before shop tests.
- B. Product Data: Provide manufacturer's literature including general assembly, certified pump curves showing performance with VFD characteristics of pump and system, operating point indicated, NPSH curve, controls, connection diagrams and service factor.
- C. System design and pressure loss calculations at different speeds.
- D. Proposed system operation and contract description.
- E. Manufacturer's Installation Instructions: Including handling, storage and start-up instructions for pumping system.
- F. Manufacturers recommended spare parts and tools list.
- G. Manufacturer's Certificate: Certifying that pumps shall meet or exceed specified requirements at specified operating conditions.
- H. Field Reports: Submit as directed by the Purchaser.
- I. Pumping Unit Brands: KSB, Grundfos or approved equivalent.

6. Materials

- 1. The entire pumping unit parts, unless otherwise specified shall be of standard materials of the manufacturer, suitable for the specified operating conditions and contents of the well water.
- 2. All materials shall be new and of first-class quality, suitable for the purpose, free from defects and imperfections. Furbished pumping units will not be accepted.
- 3. Materials for pumping units coming in contact with pumped water shall be selected such that no part renders any harmful effect to the water for human consumption.
- 4. Materials of pumping units and valve parts shall be compatible with the corrosive and / or abrasive properties of the pumped water.
- 5. All materials or parts used in the equipment shall be tested, unless otherwise directed in conformity with applicable methods prescribed by the ASTM for mechanical, fracture, corrosion, fatigue, erosion, effect of water temperature, metallography and chemical analysis, or such other organization as may be specifically required, and generally in accordance with the best commercial methods. When requested, tests shall be made in the presence of the Purchaser; stocked material may be used, provided evidence is furnished to show that such material meets the requirements as specified herein.

6. Certified material test reports shall be furnished as soon as possible after the tests are made. The test certificates shall identify the component for which the material is to be used and shall contain all information necessary to verify compliance with the Contract Documents.
7. All the submersible pumping units shall have manufacturer brands of pump strainer. Their material and size shall be compatible to the raw or source water from the well.

7. Friction Loss

The friction losses have been assessed from a point 1.0 meters outside the pumping station wall and have been calculated at the duty flow and are based on the charts contained in the United Kingdom Hydraulics Research Station, Hydraulics Research Paper No.2 (charts for the hydraulic design of channels and pipes) Third Edition (metric units) using a roughness value as stated in the above table. The Supplier shall make his own assessment of the mains friction losses over all other conditions of operation.

The Supplier shall add to the external head stated above his own allowance for friction and other losses within the confines of the pumping station.

The friction losses stated in the tables may not coincide with the Supplier's own calculations and he should comment accordingly. However, for purposes of his Tender he should base his figures on data given herein.

8. Characteristic Curves

Characteristic and system curves for the pumps shall be supplied to scale which shall enable the Purchaser to identify the capacity of the pumps under single and multi-pump operation at the duty point. Pumps must operate to their max capacity and efficiency not less than 75% and pump must perform at all speeds within the max design efficiency.

When tested through their complete range of working head at the Supplier's premises, all the pumps shall give results which conform to the curves submitted with the Tender or any other curves subsequently approved by the Purchaser. Curves showing pump efficiency and KW loading shall also be submitted to the Purchaser for his consideration.

9. Description of Pumps

The pumps shall be submersible split case, frame mounted, multistage and shall conform to the following construction or as decided and approved by the Purchaser.

Type	Submersible borehole
Design Head	120 m (or as per site conditions)
Design discharge	200 gpm
Operating Pressure	8 bars
Maximum Pressure	10 bar

Efficiency of Pumps	:	Not less than 75 % at min & max speeds
R.P.M. Range		1740 rpm to 3000rpm
Rated Power of motor pump set		30 HP (or as selected by the manufacturer)
<u>Material</u>		
Casing		AISI 304 or equivalent
Impeller (Brass or SS)		AISI 304 or equivalent
Shaft		AISI 304 or equivalent

Each pump shall be designed to give a continuous falling head/quantity characteristic to allow parallel operation. Impeller diameters shall be at least 5% less than the maximum diameter than can be fitted into the casing. Each pump shall be fitted with a stainless-steel wire rope or space-lay cable of adequate strength and length to permit raising the pump for inspection / repair or replacement.

The stator casing, oil casing, and impeller shall be of grey iron construction, with all parts coming into contact with water protected by a coat of rubber-asphalt paint. All external bolts and nuts shall be of stainless steel. A replaceable wear ring designed for abrasion resistance shall be installed at the inlet of the pump to provide protection against wear to the impeller. The impeller shall be of a non-clog design, capable of passing solids and constructed with long throughway with no acute turns.

Each pump shall be provided with a tandem double mechanical seal running in an oil reservoir, composed of two separate lapped face seals. The lower consisting of one stationary and one rotating tungsten-carbide ring, with each pair held in contact by separate spring. The seals shall require neither maintenance nor adjustment, and shall be easily replaceable. The rotating half shall be positively driven by a spring and ball arrangement. Friction fit to the shaft is not acceptable. Conventional double mechanical seals with a single or double spring between the rotating faces, requiring constant differential pressure to effect sealing and subject to opening and penetration by pumping forces shall not be considered equal to the tandem seal specified.

Pump motor shall be housed in an air-filled watertight casing and shall have Class F insulated windings which shall be moisture resistant. The motor shall be NEMA Design B rated 155° C maximum. Pump motors shall have cooling characteristics suitable to permit continuous operation, in a totally, partially, or non-submerged condition. The pump shall be capable of running dry continuously in a totally dry condition. Before final acceptance, a field running test demonstrating this ability, with twenty-four (24) hours of continuous operation under the above conditions, shall be performed for all pumps being supplied, if required. Cable junction box and motor shall be separated by a stator-lead sealing gland or terminal board which shall isolate motor from any water or solids gaining access through pump cable.

Pump motor cable shall be suitable for submersible pump applications which statement shall be permanently embossed on the cable.

10. Pump Drive (Submersible Motor) and Flat Cable

All Electric motors for pumps shall be 3 phase, 400v, 50-60 Hz having VFD features, insulation class F with class B temperature rise or higher, IP 68, suitable for prime operation on both solar energy or power.

The pumping unit will be provided with manufacturer`s recommended flat cable 4G (3 phase + N) and spliced with round cable as per cable splicing standards using manufacturer`s recommended splicing kit.

11. Submersible Power Cable (Round)

Electrolytic circular copper conductor, class 5 or 6 (flexible) based on EN 602228, PVC nitrile flexible or thermosetting insulation rubber (E14), PVC nitrile flexible or thermosetting rubber (Type EM 2) outer sheath.

Color code (4G) Brown+ Black+ Grey+ Yellow/ Green, round jacked shape. The product to be marked as “Submersible Pump Cable” with rated voltage”600/ 1000 V “. The insulation and sheath material to be selected as per raw water temperature in the well sites.

The applicable standards for submersible power cable (round & flat) are: -

- | | |
|----------------|---|
| I) IEC 60332-1 | Flame retardant or fire rate cables |
| II) IEC 60228 | Conductors of insulated cables |
| III) IEEE 1018 | Recommended practice for specifying electric submersible pump cable. Ethylene-Propylene rubber insulation |
| IV) IEEE 1021 | Recommended practice for specifying electric submersible pump cable. Propylene rubber insulation |

12. Operation and Maintenance Data

- A. Operation Data: Include manufacturer's instructions, start-up data, and trouble-shooting check lists for submersible borehole & centrifugal pumps, pump VFD motors and controls.
- B. Maintenance Data: Include manufacturer's literature, cleaning procedures, replacement parts lists, and repair data for submersible borehole & centrifugal pumps, VFD motors and VFD controls.

13. Quality Assurance

- A. Perform work in accordance with manufacturer`s recommendation.
- B. Maintain one copy of document on Site.

14. Test for Pumping Units

14.1. Shop Tests

The submersible borehole pumps shall be assembled completely in the shop to ensure correct fitting of all parts and shall be match marked before shipment, unless the pump is shipped completely assembled, to ensure correct assembly in the field. The pump casing shall be tested hydrostatically under a pressure equal to 150 percent of either the sum of the pump shut off head plus the maximum suction head or the maximum working pressure whichever is greater.

The hydrostatic test pressure shall be held for not less than 30 minutes after all leaks have been stopped.

The pumps shall be tested by and at the expense of the Supplier to establish that the performance requirements of these Specifications and the Supplier's guarantees have been fulfilled. The pumps shall be tested in the manufacturer's shop and the performance tests shall be made with the entire pumping unit at different speeds. Readings shall be taken at a minimum of five capacity points, including one point with plus or minus 2 percent of capacity specified.

The tests shall be conducted in accordance with the accepted practices at minimum speed, full speed, and maximum speed and unless otherwise specified, the procedure and instruments used shall conform to the latest applicable standards.

The test shall be carried out in the presence of the representatives of the Purchaser.

The test shall cover:

- A. Determination of the total head.
- B. Determination of rate of water pumped.
- C. Measurement of input power to the pump or output power of the motor.
- D. Determination of pump efficiency at different speeds.
- E. Preparation of characteristic curve with VFD showing pump efficiency, flow and head.
- F. Measurement of reverse runaway speed.
- G. Determination of NPSH required.
- H. Minimum submergence required.

14.2. Operational Tests

Operational tests may be performed by the Purchaser on the pump before the pump is placed in service. If so desired by the Purchaser, the tests shall be repeated one month before the expiry of the defect liability period or guarantee/ maintenance Period.

14.3. Performance Tests, Capacity and Efficiency

- A. General: Within two weeks after the operation of the submersible borehole & centrifugal pump with VFD features has been approved by Purchaser, as provided in the Contract, the pumping units shall be tested by and at the expense of the Purchaser to determine whether the equipment meets the guarantees as given. If so desired by the Purchaser, the tests shall be repeated one month before the expiry of the Maintenance Period.
- B. Provision in Case of Damage or Wear: Prior to the tests, the submersible borehole & centrifugal pumps having VSD features will be inspected by the Purchaser and the Supplier. Should such inspection disclose any damage or wear has taken place the Supplier shall rectify such damages at his own cost.
- C. Capacity and Efficiency Tests: The capacity and efficiency of the submersible borehole & centrifugal pump with VSD features will be determined for as many

different heads within the range of operating heads as possible. The capacities and efficiency at the guaranteed conditions will be determined from smooth curves drawn through the test points.

- D. Conduction of the Tests: The tests will be conducted in accordance with latest applicable Hydraulic Institute Standards.
- E. Determination of Rate of Flow: The rate of flow of water through the submersible borehole & forwarding centrifugal pump will be determined by the properly calibrated flow meter to be installed at well station.
- F. Determination of Total Head: Total head on submersible borehole the pump (H) will be the difference between the pressure elevation at the pump discharge and the pressure elevation near the entrance to the suction elbow, both corrected for velocity head.
- G. Determination of Power: The electrical input to the motor will be measured by using accurate, sensitive and calibrated, test instruments connected to the permanently installed instrument transformers or as directed by the Purchaser. The input to the pump will be the measured input to the motor minus the mechanical and electrical losses in the motor. The losses in the motor will be determined by separate tests in accordance with the latest standards and test codes of the Institute of Electrical and Electronic Engineers, Inc; and the American National Standards Institute.
- H. Determination of Efficiency Curve: The efficiency curve of the submersible borehole pump will be determined at various frequencies of the input, head and rate of flow of water, all as determined in accordance with the above sub-paragraphs.
- I. Runaway Tests: The submersible borehole pumps will be subject to runaway tests & witnessed by the Purchaser. The tests will be performed under normal operating conditions by interrupting the power supply.

14.4. Vertical Turbine Pump Set

Pumps shall be of the open line shaft water lubricated vertical turbine type for installation and operation in tube-wells and shall be suitable for use with vertical, hollow-shaft, squirrel cage induction type motors. All pumps shall consist of pump bowl assembly, column pipe, line shaft and surface discharge head assembly, including water pre-lubrication system as required and all other parts and appurtenances to provide a complete operating pump in accordance with these specifications and as per BoQ.

a) Design

The material, design, fabrication and assembly of equipment shall be in strict accordance with American Water Works Association Standard A 101-61 Entitled "American Standard for Vertical Turbine Pump", or latest revision and the following requirements:

1. General

Water Pumps shall be vertical shaft centrifugal pumps with rotating impellers and discharge from the Pumping elements coaxial with the shaft. The pumping element shall be suspended by the conductor system which encloses a system of vertical shafting used to transmit power to the impellers, the prime mover being external to the flow stream. The basic pump shall consist of the following three elements:

Pump Bowl Assembly

The pump bowl assembly shall be either a single or multistage, centrifugal vertical pump with discharge coaxial with the shaft.

Column and Shaft Assembly

The column and shaft assembly shall consist of the column pipe which suspends the pumps bowl assembly from the head assembly and serves as conductor for the fluid from the pump bowl assembly to the discharge head. Contained within the column pipe shall be the line shaft which shall transmit the power from the driver to the pump shaft. The line shaft shall be supported throughout its length by means of bearings which are lubricated with water.

Head Assembly

The head assembly shall consist of the base (from which the column and shaft-assembly and the bowl assembly shall be suspended) the discharge head which directs the fluid into the desired piping system and the driver.

2. The Driver Coupling

The driver coupling is the mechanism, which transmits the power to the top shaft. It shall contain means for impeller adjustment and provide a bearing to carry the thrust load.

3. Discharge Head

A cast iron flange shall be integrally cast on the discharge head. The discharge flange shall have a companion flange suitable for connection to the discharge pipe.

4. Motor Mounting Flange

The motor mounting flanges of pumps shall match the NEMA flanged base plates of motors and base plates of right-angle gears.

b) Manufacture

The pumps shall be those manufactured by M/s KSB or equivalent of the types as specified. The pumps shall be manufactured to meet the characteristics specified on the drawings or as directed by the Engineer-in-Charge.

1) Pump Element

The impellers shall be the enclosed skirt seal type constructed of bronze meeting the requirements of ASTM Standard B 145-61 titled "Leaded Red Brass and Leaded Semi-Red Brass Sand Casting". Impellers shall be accurately fitted, smoothly finished, and dynamically balanced at the normal pump speeds. The bowls shall be constructed of close-grained cast iron. The inside of each bowl shall be hand finished to mirror-like smoothness. Three or four stage pumps as approved by the Engineer-in-Charge shall be supplied by the Contractor. Each suction bowl shall be fitted with a grease-packed bronze bearing and suction case plug. A suction case and collar shall be provided to protect the bearings. Each pump bowl shall have a fluted rubber bearings above each impeller and shall be designed for the future installation of bronze or cast-iron wear rings. Each discharge bowl shall be equipped with a bronze bearing. The pump and line shaft shall be of stainless-steel conforming to ASTM Standard A 276-60 entitled Hot-Rolled and Cold-Finished Corrosion Resisting Steel Bars", type 416, and shall be of suitable size to transmit the loads and to maintain correct alignment without distortion or vibration. The pump shaft shall be turned, ground and polished and shall be threaded for connection to the line shaft.

2) Column Pipe and Line Shaft

The column pipe shall be furnished in interchangeable sections having a normal length of 10 feet. Wall thickness shall be minimum 0.234 inches. . The ends of each column pipe section shall be faced parallel and perpendicular to the axis of the pipe. The threads shall be machined so that adjoining sections of column pipe will butt together to ensure proper alignment on assembly. The line shaft shall be ground carbon steel shafting in accordance with ASTM Standard A 108-61T entitled "Cold Finished Carbon Steel Bars and Shafting" Grade 1020 or 1045 and shall be furnished in interchangeable sections having a nominal length of 10 feet. The ends of the shaft sections shall be faced parallel and perpendicular to the axis of the shaft. Adjoining sections of the line shaft shall be connected by means of threaded, sleeve-type couplings of the same material as shall be supported by fluted, oil resistant, rubber bearings designed to be lubricated by water. The bearings shall be mounted in bronze bearing retainers which shall be threaded into the column couplings and butted against the adjoining section of column pipe. The rubber bearing shall be replaceable within the bronze bearing retainers and shall be spaced at intervals of not more than 10 feet along the line shaft.

3) Surface Discharge Head

Each surface discharge head shall be of the above ground type and shall be a suitable base for supporting the specified electric motor and the pump column. The discharge head shall be of cast iron conforming to ASTM Standard A 48-62 titled "Standard Specification for Grey Iron Casting" Class 30 A or an approved equal quality of casting. Each surface discharge head shall be furnished with an integral ASA 125-pound flange conforming to ASA B16-1-1948 "Cast Iron Pipe Flanges and Flanged Fittings, Class 125". The discharge heads shall include half couplings connecting to discharge pressure and suction pressure to accommodate gear cooling water lines as required by the gear drive unit.

4) Pre-lubrication System

The contractor shall furnish a manually operated water pre-lubrication system complete with all valves piping and storage tank for the turbine pump. The piping for pre-lubrication system shall be complete with necessary valves, lines and fittings to permit filling of the pre-lubrication tank from the pump discharge and to permit the water to be manually released prior to starting pump. The prelubrication tank shall be an enclosed tank of sufficient size to adequately lubricate the line shaft bearing before pump start-up and shall be equipped with an opening in the top through which it may be filled from the pump discharge or from an outside source.

c) Quality Control Tests

The manufacturer shall perform all the quality control tests as specified hereafter and all test results and anticipated field performance curves shall be submitted in triplicate, to the Engineer-in-Charge. Pumps must operate at their max capacity with high efficiency (not less than 70%).

1) Standard Running Test

The pump bowl assembly shall be operated from zero capacity to the maximum capacity shown on the performance curve submitted with the manufacturer's bid. Readings shall be taken at a minimum of 5 capacity points, including one point within + 2% of design capacity specified. The pump shall be operated at a speed within + 5% of the design speed.

2) Capacity Measurement Test

The capacity of the pump shall be measured by means of a standard venturi tube, nozzle orifice plate or pilot tube traverse.

3) Head Measurement Test

For head measurement in excess of 36 ft. calibrated bourdon or other gauges with equivalent accuracy and reliability shall be used. All gauges shall be calibrated before and after each series of tests.

4) Test for Velocity

The average velocity in the pump column used to determine the velocity head shall be calculated from dimensions obtained by actual measurement of the pipe and shaft or enclosing tube diameter and the velocity head shall be obtained from actual measurement of the inside diameter of the discharge pipe at the point where the pressure tap is located.

5) Horsepower Input Test

The power input to the pump shall be determined with vertical dynamometer or a calibrated electric motor. Calibrated laboratory type electric motors and transformers shall be used to measure the power input to all motors.

6) Measurement of Speed

The rotating speed of the pump shall be obtained by a hand counter, electronic computer or a counting slip.

7) Hydrostatic Test

A standard hydrostatic test on the pump bowl assembly shall be made at 1 ½ times the shutoff head developed by the pump bowl assembly or at twice the rated head, whichever is greater.

14.5. Motors**a) Pump Motors**

The pump motors shall be compatible and vertical hollow shaft fan coated totally enclosed weather protected squirrel cage, induction type and shall have 4 poles with approximate speed of 1460 rpm on 400 volts, 3 phase. 50 cycles. The motor horse power for each site shall be indicated in the Bill of Quantities. When operating continuously at full rated load, the temperature rise shall not exceed 40 degrees centigrade above an ambient temperature of 50 degree centigrade. The motor shall have a service factor of 1.15 times the rated horsepower and horsepower loadings shall not exceed the name plate at any point on the pump performance curve. The motors shall conform to NEMA Standard MG 1, titled "Motors and Generators" for a class B design and shall have low starting current and normal starting torque. The locked rotor input shall not exceed 5.6 KVA per horsepower. The winding shall have Class B insulation and shall be suitable for operation under conditions of high humidity and at an ambient temperature of 55 degree centigrade. Each motor shall be equipped with three thermal devices embedded and symmetrically spaced in the stator winding. These devices shall operate on temperature rise to de-energize the control circuit of the motor thus disconnecting it from the power source. The thermal devices shall be so located in the winding and so constructed that they will prevent motor damage due to overheating resulting from overload, lack of ventilation, single phasing, stalling, high ambient temperature or Voltage imbalance. The pump motors shall be designed for mounting on the surface discharge, head and for direct connection to the line shaft. A thrust bearing of adequate capacity to carry the weight of all rotating parts, plus the hydraulic thrust shall be provided on each motor. The motors shall be provided with a completed oil or grease lubrication for each bearing. Each motor shall be provided with a non-reverse ratchet to prevent reverse rotation of the pump.

b) Motor Control

The motor controls for each motor shall consist of motor starter and control switches with all necessary components for a complete installation. Each motor control shall be suitable for controlling and protecting 400 volts, 3 phase 50 c/s electric motor. Motor controls shall be furnished in complete accordance with the applicable provisions of NEMA Standard 1 CI, entitled "Industrial Controls" shall have a minimum insulation level for 600-volt class equipment, and shall be designed to provide short circuit protection in all phases and overload protection in all three phases. The thermal overload relay reset device shall be mounted to be operable without the necessity of opening the casing. Each motor control shall be furnished complete as a unit with all component parts and accessories completely wired to conform to NEMA Class-II construction, Class-B wiring. The conductor shall be 600 volt, Heat resistant, thermoplastic insulated wire suitable for 75° operating temperature. A weather proof enclosure NEMA Type-III with a lockable outer door, shall be provided.

14.6. Installation

Installation shall include all bolts, nuts, washers, shims, fittings, grout and other materials required for proper installation of the equipment which are not supplied as part of the equipment. Equipment damage during the course of installation shall be repaired or replaced by the Contractor at his own expense.

a) Pumps and Motors

The Supplier shall carefully clean, assemble, align and install the pumps in accordance with the manufacturer's recommendations. Care shall be taken that all connections are clean and free from burrs and foreign material so as to ensure tight fit and proper alignment. Connections between adjoining sections of column pipe and line shaft shall be correctly assembled and tightened to maintain accurate alignment. A suitable thread lubricant shall be used on all threaded connection to facilitate disassembly for maintenance. The pumps and motors shall be installed in tube-well in accordance with the manufacturer's instructions. The surface discharge heads shall be accurately set on the concrete pump platforms shown on the drawings and shall be aligned with pump housing casing. The surface discharge heads shall be rigidly connected to the reflux (check) valve and the dresser-type couplings. All the fittings shall be properly installed as shown on the drawings. In order to ensure the accurate and proper alignment of the pump, anchor bolts shall set only after the pump has been set and aligned. Anchor bolt holes may be formed in the concrete platform as the concrete is placed or may be drilled in the concrete after the concrete has set thoroughly. The anchor bolts shall be minimum 5/8 inch diameter and minimum 12 inches long with nut and lock washer, and shall be set in the anchor bolts holes with sufficient extension to permit the full threads of the nuts to be engaged by the anchor bolt. The anchor bolts shall then be set in cement grout. Where holes are drilled after the concrete has set thoroughly, expansion bolts or lead expansion anchors may be installed at the option of the contractor in lieu of grouting anchor bolts. Non-shrink grout shall be placed under the entire surface of the discharge head to provide proper support for the pump. Non-shrink grout shall conform to the applicable requirements set forth in the Specifications for concrete.

14.7. Electrical Work

The work shall consist of furnishing all plant, labour, equipment, appliances, and materials and in performing all operations in connection with the electrical work in strict accordance with the applicable specifications

14.8. Chlorination Equipment**a) Chlorinator**

Chlorinator shall be of vacuum solution feed, manually set cylinder mounted type. Chlorinator shall be capable of meeting requirements of water flows ranging from 1 cusecs to 2 cusecs and delivering upto 1 lb/hr. of chlorine gas in solution to give a maximum dosing rate of 2 ppm. The chlorinator shall be supplied complete with all standard accessories and complete in all respects to ensure satisfactory operation.

b) Chlorinator Accessories

The chlorinator should include among its accessories an injector or as described in the BOQ. A water booster pump with electric controls, a chlorine gas inlet connected via pressure regulating valve, a linear feed rate indicator, a feed rate adjuster, a pressure relief valve, a drain relief valve, and chlorine pressure gauge.

c) Booster Pump

The Contractor shall supply alongwith each chlorinator a water pump for booster water pressure to meet, requirement of the chlorinator. The pumps shall have adequate pumping capacity and to ensure proper mixing of chlorine and water in the injection assembly of chlorinator. The pumps shall be electrically driven by single phase motor capable of operation on 220 V, 50 Hz, with + 10% fluctuation in voltage. The pumps shall be supplied complete with suction and delivery isolating valves. Check valves, pressure gauge and appropriate starters.

d) Empty Gas Cylinders

The Contractor shall supply with each chlorinator two 150 lb. empty chlorine cylinder designed and fabricated in accordance with AWWA or A.S.T.M. Specifications or equivalent. The welded seams shall be fully stress relieved after fabrication. A corrosion Allowance of 1/16 inch shall be provided for the design thickness of the cylinders. Material of construction shall be according to ASTM A-515 Grade 60 or ASTM A -285 Grade C or equivalent. Cylinder shall be provided with matching outlets corresponding to chlorinator offered under this Contract. Each cylinder shall also have a protection cap provided along-with the cylinder.

14.9. STANDBY GENERATOR**a) Requirement**

The Contractor shall provide, install and carry out testing of diesel generator set with necessary electrical installations, distribution board and batteries as per requirement mentioned in the BOQ. The diesel generator set shall be supplied by a reputed manufacturer such as Caterpillar, Cummins, Perkin, F.G. Wilson or equivalent etc., and its design will be the responsibility of contractor. The contractor shall be responsible for design and getting approval from client and consultants and then ordering diesel generator set from the manufacturer.

The manufacturer shall design and submit detail specifications, calculations along with fabrication drawings to the Engineer. Manufacture shall commence after the written approval of the Engineer. Installation's drawings and method statement of installation shall be submitted by the Contractor for approval of the Engineer. The erection of diesel generator set shall be in the supervision of Manufacturer's Site Engineer.

b) Standards

All material and equipment supplied by the manufacturer/supplier shall be new and in all respects, conform to the high standard of engineering design and workmanship, perform and function as herein specified and fully meet the specifications requirements of the latest standards of International Electro Technical Commission.

c) Standard References

- The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
- National Electrical Manufacturers Association (NEMA)
- NEMA MG 1 (2003) Motors and Generators
- National Fire Protection Association (NFPA)
- NFPA 70 (2002) National Electrical Code
- Institute of Electrical and Electronics Engineers (IEEE)
- IEEE-C37.20.1 (2002) Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear

d) Field Installation Drawings

Field installation drawings shall provide a detailed description of the field installation procedures. The description shall include the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment.

e) Tests, Inspections, and Verifications

Certified test reports for material tests shall be submitted with all materials delivered to the site.

f) Diesel Generator Installation

Diesel generator set shall be assembled for installation in strict accordance with the approved installation drawings, and shop match-markings. Bearing surfaces requiring lubrication shall be thoroughly cleaned and lubricated with an approved lubricant before assembly and installation. Use cribbing and shoring as required to protect construction from moving-in damage. Protect flooring and finished surfaces by heavy planking. Obtain approval of methods and materials used from the Engineer before moving equipment across shored floors. After equipment has been moved in, remove shoring and repair damage to floors and other parts of the building. Furnish the services of one or more Diesel-Generator representative or technicians, experienced in the installation and operation of the type of systems being provided, to supervise the installation.

Installation shall be in accordance with manufacturer's instructions. Furnish a competent and experienced erecting Engineer to directly supervise unloading, moving, and erection of equipment. Provide labour, tools, and equipment, for erection and installation of the equipment.

g) Engine-Generator Unit Acceptance Tests

When installation is complete and in operating condition, notify the Engineer in writing that the engine-generator units and auxiliary equipment are ready for final field tests. The Engineer or the Engineer's authorized representative will witness final acceptance tests. Conduct fuel consumption

tests on the engine-generator units to determine compliance with the specification requirements. Perform such other tests as necessary to ensure that equipment is functioning properly. Tests shall include the following.

- A test to determine engine-generator unit speed regulation under a gradual change from zero to full load.
- A test to determine engine-generator unit instantaneous speed change with 25 percent load on or off.
- A test to ensure proper functioning of the over speed trip.
- An individual test of each pressure and temperature alarm switch.

Inspect auxiliary equipment including, but not limited to, pumps, compressors, fans, coolers, radiators, instruments, centrifuges, and special valves to ensure proper operation. Engineer may require to field test the auxiliary equipment. Auxiliary equipment test shall be in accordance with the latest ASME and IEEE performance test codes, if applicable.

14.10. Guarantee

Equipment furnished shall be guaranteed for a period of one year from date of acceptance hereof against defective materials, design, and workmanship or as stated in the Contract. Upon receipt of notice from the Engineer of failure of any part of the guaranteed equipment during the guarantee period, new replacement of part or parts of same trade mark as provided originally shall be furnished promptly by the Contractor at no additional cost to the Department.

a) Operation and maintenance Manual

The Supplier shall furnish 6 copies of an illustrated operation and maintenance manual with each piece of equipment furnished under this section.

b) Spares and Tools

The Supplier shall furnish common spares such as O-rings, bushing, bearing, other similar items and special tools for each piece of equipment furnished under this section for its efficient service for over 3 years period.

14.9. Transformers

The Supplier shall design, manufacturer, test, supply, deliver and install all transformers as required in the price schedules and these specifications in accordance with relevant WAPDA specifications.

The Transformers will be installed outdoors, at ambient conditions as per the site of installation in District Sibi. The supplier shall submit programme for production and testing. The equipment shall comply with the latest editions and amendments of the international standards.

The continuous rating of the distribution Transformers shall be 50kVA, 100 kVA and 200 kVA. Each Transformer shall be capable of supplying its rated power being the product of rated voltage and rated current on the line side winding (at center tap) expressed in kVA, as defined in IEC 60076-1.

All equipment, including accessories, shall be packed and securely clamped against movement in robust, non-returnable packing cases to ensure safe transit from the manufacturer's works to the agreed point of delivery. The base of the packing case shall be strong enough to carry the weight of the transformer and be large enough so that no part of the transformer and accessories such as pipes, valves, etc extends beyond the edge of the pallet.

TECHNICAL SPECIFICATIONS

PART V – CIVIL WORKS

1. Earth Works

1.1 General

The Contractor shall examine the site and familiarize himself with the nature of the ground and any other local conditions, excavation methods to be applied and physical obstructions that may affect his work and prices. His rates shall allow for all operations and costs required and encountered when carrying out the works in accordance with the Contract. Claims due to lack of knowledge of site conditions will not be entertained. The Engineer should advise him in economical excavation method to minimize the cost of the project.

The Contractor shall not execute any earthwork or excavation without having the Engineer's prior approval to the methods and equipment, which he proposes to employ. He shall not thereafter modify such methods without the Engineer's consent.

1.2 Definitions

- (1) "Excavation" shall for the purpose of the Contractor be deemed to refer to the excavation of all the materials of whatever geological formation, quality, consistency or description.
- (2) "Rock Excavation": The word "rock", wherever used as the name of an excavated material to be excavated, shall mean only boulders and pieces of concrete or masonry exceeding 0.30 m³ in volume, or solid ledge material which, in the opinion of the Engineer, requires, for its removal, drilling and blasting, wedging, sledding, barring, or breaking up with a power-operated tool.

1.3 Precautions

Excavation shall be carried out neatly to the lines and levels, which are specified on the Drawings or as instructed by the Engineer.

The Contractor shall take all possible precautions to prevent slips in excavations. Excess excavation beyond the specified lines and levels shall be limited to an absolute minimum making due allowance for working space and necessary Temporary Works.

Any excess excavation, overbreak or slip beyond the limits of the specified excavation shall be removed and made good at the Contractor's expense with such material as the Engineer shall direct.

Excavation shall be carried out by hand if excavation by mechanical means is not reasonably practicable or may endanger or damage structures or property.

Excavated material shall, if in the opinion of the Engineer's Representative is suitable and required for use at the Site, be stockpiled or, if possible, immediately placed or shall, if not so suitable or required, be removed from the Site.

No soft or disintegrated material which can be removed with a hand pick or power-operated excavator or shovel, no loose, shaken, or previously blasted material or broken stone in material fillings or elsewhere, and no material exterior to the maximum limits of measurement allowed, which may fall into the excavation, will be measured or allowed as "material".

Excess Rock Excavation: If rock is excavated beyond the limits of payment indicated on the drawings, specified, or authorized in writing by the Engineer, the excess excavation, whether resulting from over breakage or other causes, shall be backfilled, by and at the expense of the Contractor.

1.4 Excavation

1.4.1 Excavation Rates

The rates for excavation shall include for:

- Excavation in any material including rock.
- Careful removal, storage and replacement of top soil as directed by the Engineer.
- Bulking of the excavation material.
- Temporarily supporting the sides of the excavations.
- Additional excavation to accommodate the temporary supports and all working space necessary to carry out the work together with all subsequent backfilling and compaction using approved excavated material.
- Keeping the excavations clear of water (including groundwater) and all dirt at all times until pipe laying and testing or construction work is completed and permission for backfilling is obtained.
- Trimming, compacting and protecting the formation level.
- Formation of all temporary spoil heaps and all double handling necessary, and carting away excess material to tip.
- Protection of the Works as in sub-section 1.26.

All surface areas which items which have been disturbed by the Contractor's working or operations shall be reinstated to the original condition at the Contractor's expense where directed by the Engineer.

1.4.2 Trench Excavation

The line and level of trench shall be as shown on drawings or as directed by the Engineer. Before commencing excavation, the alignment of the trench shall be pegged out accurately and the ground level shall be agreed with the Engineer. Strong sight rails shall be then fixed and maintained at each change of gradient and at a distribution board distance not exceeding 25 meters.

Trench excavation shall be carried out by such methods and such lines, dimensions and depth as required for the proper construction of the Works to meet the local condition of the Project Area.

No length of trench excavation shall be started until pipes, etc. to be laid in that length are available on Site.

Any widening or deepening of trench necessary to accommodate curves, bends, joints etc. shall be considered as Over Break.

Except where otherwise stated trenches shall be excavated to a sufficient depth to ensure, after consolidation of the backfilling, a minimum cover below ground level as shown in drawings. Where the Contractor is instructed that the pipe line shall be laid at a lesser depth, the ground surface shall be made up locally with banking or concrete surrounding to the pipe shall be provided all in accordance with the Engineer's instructions.

Subject to any specific requirements of the Contract the backfilling and temporary surface reinstatement of trench excavation shall be commenced and be completed as soon as reasonably practicable after the pipes have been laid and joined. Pipe laying shall follow closely upon the progress of trench excavation and the Contractor shall not permit unreasonably excessive length of trenches to be open while awaiting testing of the pipeline.

If the Engineer considers that the Contractor is not complying with any of the foregoing requirements, he may prohibit and further trench excavation until he is satisfied with the progress of laying and testing of pipelines and backfilling of trench excavation.

All trench excavation and other work carried out within the limits of any roadway shall be completed as rapidly as possible and not more than the width of the carriage way shall be obstructed at one time. The Contractor shall provide maintain and operate temporary traffic controls of a type approved by the Engineer.

The rate for trench excavation shall include for working along the line of old sewer trenches or in close proximity to old sewer trenches as the case may be. Rates should also include for excavations encroaching on and adjacent to service trenches.

Trench excavation in roads and at thrust blocks in all locations shall have vertical sides.

The Contractor shall all times take special precautions to prevent settlement in the vicinity of the trenches. The Contractor shall make good any settlement and repair any damage resulting from such settlement at his own cost and all to be the satisfaction of the Engineer, the land owner or the highway authority. This is in no way intended to limit the Contractor's responsibilities under clause 22 of the conditions of Contract Part I.

All topsoil shall be carefully laid aside and afterwards replaced in its original position.

Accurate record shall be kept by the Contractor of all services crossed in the course of work. The Contractor shall prepare record drawings showing the location level and details of the services which are crossed and such records shall given daily to the Engineer.

In case of crossing of existing services with the projected alignment of pipes, refer to Section 1.12.

1.4.3 Trimming Excavation

Where excavation to specified levels for the foundation of structures or for pipes or to the specified limits for the face of any structure required to abut undisturbed soil the Contractor shall not excavate the last 150 mm until immediately before commencing the constructional work, except where the Engineer shall permit otherwise.

Should the Contractor have excavated to less than 150 mm of these specified limits before he is ready to commence the constructional works, he shall, where required by the Engineer excavate further so as to remove not less than 150 mm of material immediately before commencing the constructional works. Any additional work and costs related thereto are considered as Over Break.

Where no bedding material is specified or instructed to be laid beneath the pipe, the bottom of the trench shall be carefully trimmed true to level and grade so as to ensure a continuous support for the pipe barrel, pockets for couplings and / or flanges are to be excavated below the invert level. The trench bottom shall be pricked over with a rake and any stone or flint likely to cause the pipe to bed unevenly or to damage the pipe and its coating or greater than 20 mm in size shall be picked out of the pipe bed.

Before commencement of any constructional work all shattered and loose material shall be removed from the excavation by hand so as ensure that the Work rests on a solid and perfectly clean foundation or abuts against solid soil.

1.4.4 Unsuitable Material

The Contractor shall be responsible for forming a sound foundation for pipes, pipes bedding structures and he shall make all tests and bring to the attention of the Engineer any inequalities in the bearing capacity of the subsoil. Any additional excavation ordered by the Engineer to be carried out and the subsequent refilling with suitable material shall be measured and priced at Contract rates.

Should the Contractor fail to comply with the above he all shall be responsible for all breakage, fractures, leakage's, settlement, etc. that may occur as a result of the aforesaid inequalities of the bearing capacity of the subsoil.

Should the material forming the bottom of any excavation, while acceptable to the Engineer at the time of his inspection, subsequently become unacceptable to him due to exposure to weather conditions or have become puddles, soft, loose during the course of the works, the Contractor shall remove such unsound material by hand. Such further excavation shall be held to be Over Break.

Unsuitable material shall be removed from site and disposed of as instructed by the Engineer.

1.4.5 Supporting Excavation

If required or instructed by the Engineer's Representative all sides of excavation shall be supported to prevent settlement or slip falls of ground. Structures, services adjacent to the excavation. Excavation

required providing space for supports and working area as well as slip falls and settlements of ground adjacent to excavation are to be considered as Over Break. Remedial measures repairs and related costs encountered due to settlement slip falls damages are to be carried out and paid for by the Contractor.

1.4.6 Disposal of Excavated Material

Excavated material, which is not required or is unsuitable for re-use in the Works shall be disposed of as directed by the Engineer. The Contractor shall give the Engineer adequate notice of his intention to spoil. Material ordered to be disposed of shall remain the property of the Employer and shall deposit at places designated by the Engineer.

Subject to any specific requirements of the Contractor, the disposal of excavated material within the Site shall be at the Contractor's discretion but shall be so arranged as to be acceptable to the Engineer and to overall requirements for the construction of the works. The Contractor shall ensure that no excavated material which is suitable for and is required for re-use in the works is disposed of outside the Site.

The term "excavation" shall be deemed to include for disposing of excavated material in any of the following ways:

- (a) Backfilling to excavation and completed structures and trench excavation using suitable excavated material and including placing in temporary spoil tips and any double handling required.
- (b) Transporting selected excavation material to locations within the Site where embankments are to be constructed or where filling around structures is specified to be constructed as embankment including ripping ready for spreading and compacting.
- (c) Disposal of surplus excavated material outside the Site.
- (d) Top soil and excavated material suitable for grassing shall be deposited in temporary separate spoil tips within the Site.
- (e) Unsuitable material shall be disposed of as approved by the Engineer.

1.4.7 Blasting

Explosives shall be used only with the prior written permission of the Engineer and under conditions to be approved by him. The Contractor will required to indemnify the Employer against all claims arising therefore in respect of persons, animals, properties and services. Blasting shall be carried out carefully and such manner as to avoid loosening or shattering rock beyond the required line of excavation and all loose and shattered rock shall be removed and any voids formed and made good to the satisfaction of the Engineer and at the Contractor's expense. Only experienced and qualified personnel shall be employed on this work and the storage of explosive shall conform to the appropriate regulations. The Contractor will familiarize himself with and conform to any local Authorities regulations concerning blasting.

1.4.8 Existing Services

Notwithstanding any relevant information furnished by the Employer of the Engineer or any public authority, the Contractor shall be solely responsible for ascertaining from his own inspection of the Site and from the respective supply authorities and other public or private bodies the position of all pipes and cables whether underground or overhead within or near the Site.

Where excavation is out close to or across or below the existing line of sewers, pipes, cables or other services, the Contractor shall where required provide temporary supports or slings and where such sewers, pipes, cables or other services are damaged the Contractor shall arrange for and pay repair works replacement or costs resulting from such damages.

Where in the opinion of the Engineer construction of the works cannot be reasonably carried out unless the sewer, pipe, cable, other service is permanently served or permanently diverted or permanently supported, he will instruct the Contractor to provide all necessary facilities and access for the Government Department or public utility company who shall out such works or shall instruct the Contractor to execute these works.

For more information on existing services crossing refer to section 1.12.

1.4.9 Excavation to be kept Free from Water

The Contractor shall allow in his rates for excavation for keeping the excavation whether above or below the Groundwater table, at all times, free from flooding by storm water, percolating water, subsoil water, sewage irrigation water or sewage effluent by pumping, bailing or other means.

No water or sewage effluent shall be discharged into any water course, onto roads tracks footpaths yards or any other area used by vehicular or pedestrian traffic unless approved by the Engineer. Such permission shall not be granted unless the Contractor shall have provided efficient setting basins or sand traps to retain all sand and other solids likely to settle. The permission to discharge liquids shall be liable to be withdrawn at any time in the event of circumstances arising and which in the opinion of the Engineer shall make such a discharge undesirable. The Contractor shall have no right to claim in respect of withdrawn of such permission.

The Contractor shall take all precautions to avoid undermining of any part of the works or other properties by pumping or else, but should undermining occur he shall make good same to the satisfaction of the Engineer at the Contractor's expenses.

In all cases where permissions to use existing water courses, sewers, pipes for the discharge of liquids has been granted, it will be on the condition that the Contractor cleans out such facilities after completion of the works at the respective Site.

It is expected that in certain areas the high level of the water table will present problems during excavation. The Contractor shall satisfy himself as to the extent of this problem and make due allowance in his tender for draining and maintaining all works in a dry condition during construction. Water removed from excavations must not be allowed to cause nuisance or damage to traffic or any public or private property or service. In no circumstances shall dewatering arising be discharged into any part of the sewerage system.

All proposed methods for dewatering excavations shall be submitted to the Engineer for his approval. The responsibility for dewatering rests with the Contractor for the duration of the Contract. Care shall be exercised during dewatering so that no material in or around the excavations is disturbed as result of dewatering.

The payment for dewatering shall be made on lump sum basis in accordance with the relevant item for dewatering of pipeline trench included in the BoQ

1.5 Earthfill and Backfilling

1.5.1 Backfilling of open Excavation other than Pipe Trenches

Backfilling of the excavations shall not be carried out without the consent of the Engineer.

Excavation shall be carried out in such a manner that material which is unsuitable for backfilling and compaction shall be excavated separately and removed from the Site.

Examples of unsuitable materials for backfilling are as follows:

- (i) Materials from swamps, marshes and bogs;
- (ii) Vegetable matter, timber or similar material liable to decompositions;
- (iii) Materials susceptible to spontaneous combustion;
- (iv) Clay or earth having excess liquid content;
- (v) Rock over 100 mm in any dimension.

Material for backfilling shall be deposited and compacted in layers of a maximum thickness of 300 mm and be appropriate to the compaction plant used. (Thickness measured prior to compaction). Compaction shall be so carried out to ensure a value of 95 % Proctor is achieved.

Supports to the excavation shall be carefully removed as the filling proceeds, but the removal of such supports shall not relieve the Contractor of his responsibility for the safety and stability of the Works.

1.5.2 Backfill Pipeline Trenches

The backfill of pipeline trenches shall be made in accordance with Section 4: Pipe Bedding and Backfilling of Trenches.

1.6 Forming Slopes, Embankments and Cuttings

- (1) The slopes of any banking shall be accurately and uniformly dressed off to slopes as shown on the Drawings or such other as may be directed by the Engineer.
- (2) The Engineer may order excavated material to be used in forming embankments or making up low ground. Only suitable material shall be used for such work.
- (3) Material used shall be spread in layers not exceeding 300 mm deep, each layer being well compacted, to ensure a value of 95 % Proctor density is achieved.

1.7 Offensive Matter

Any offensive matter found in the excavation shall be dealt with immediately by the Contractor at his own expense. He shall remove, disinfect with chloride of lime or other strong disinfectant and cart away such matter to an approved site for burial or otherwise completely dispose of as necessary. Other precautions may be detailed by the Engineer.

1.8 Measurement and Payment

1.8.1 Excavation

1.8.1.1 Measurement

Measurement, for payment, of surface excavation will be made of the volume of material excavated to the lines, grades and dimensions shown on the Drawings or directed and shall be taken only in the presence of the Engineer. The Engineer shall be notified at least 24 hours before such measurements are taken. Before commencing and immediately after completion of surface excavation, the Contractor shall take survey measurements sufficient to define the dimensions and elevations of the original and final surfaces.

Measurement will not be made separately for “common” and “rock” excavation.

The measurement will not include the volume of subgrade material or other material that is scarified or plowed and reused in-place, and will not include the volume excavated without authorization or the volume of any material used for purposes other than directed. The measurement will not include the volume of any excavation performed prior to the taking of elevations and measurements of the undisturbed grade.

1.8.1.2 Payment

Payment for the various items of surface excavation will be made at the applicable rates per cubic meter tendered therefor in the priced Bill of Quantities. These rates shall include the cost of all labour,

materials, temporary construction, pumping, bailing, draining and all other work necessary to maintain the surface excavations in good order during construction, and of removing such temporary construction if so directed. These rates shall also include the entire cost of clearing and stripping of soil, of excavating and transporting the materials from the excavation to the point of final use, or to disposal; and, where stockpiles are used. The cost of transporting the material to the stockpiles; of re-handling and of transporting such material to the point of final use; and the entire cost of cleaning up excavated surfaces.

Direct payment will not be made for excavation carried out in borrow area or quarries in accordance with this Clause. The cost of all work in the quarries and borrow areas including clearing, excavation, separating, selecting, processing, hauling and dumping of unsuitable materials and of soil conservation measures shall be included in the rates tendered in the Bill of Quantities for the items for which the materials from the quarries and borrow areas are used.

1.8.1.3 Unit of Measure

Unit of measure: Cubic Meter

1.8.2 Backfill

1.8.2.1 Measurement

Measurement, for payment, of furnishing, placing and compacting backfill will be made of the volume of material in place to the lines grades and dimensions shown on the Drawings or directed.

1.8.2.2 Payment

Payment for furnishing, placing and compacting backfill will be made at the rate per cubic metre tendered therefore in the priced Bill of Quantities. Material from required excavation or from the quarry used for backfill will be paid for both as excavation when removed and as backfill when placed. Payment will not be made for excavating materials from stockpiles or sources other than required excavation.

1.8.2.3 Unit of Measure

Unit of measure: Cubic Meter

2. Concrete

2.1 General

Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water and admixtures as specified, all well mixed and brought to the proper consistency.

All concrete and its constituent materials and all methods and procedures shall conform to applicable standards of the British Standards Institution otherwise specified.

The costs of all tests of concrete and/or its components shall be deemed to be included in the rates.

All equipment employed for concrete works require the approval of the Engineer prior to dispatching to the Project.

2.2 Cement

Unless otherwise specified the cement used in the Works shall be sulphate resisting Portland Cement (SRPC) complying with B.S 4027. Where specified or ordered Ordinary Portland Cement (OPC) complying with BS12 standard current at the time shall be used.

The cement to be used in the works shall be obtained from an approved manufacturer. For each delivery of Cement the contractor shall furnish, free of cost, test certificates as directed by the Engineer, relating to the cement to be used on the work. Analyses of the cement shall be shown.

The Contractor shall maintain a record available for inspection by the Engineer of the locations of cement from each consignment.

The Contractor shall supply samples of cement, when requested by the Engineer both from any store on Site and the place of manufacture.

2.3 Aggregates

Aggregates for concrete shall comply with BS 882 current edition.

Fine aggregate shall consist of natural sand and shall comply with requirements of Table 4 of BS 882. The Engineer will permit the addition of suitable crushed rock fine aggregate, as necessary, to the sand where in his opinion it is impracticable to obtain the specified grading of the combined aggregates otherwise than by such addition. The maximum quantities of particles smaller than 75mm shall, in any event, not exceed 3% by weight when the sample is tested to BS 812: Section 103.1.

Coarse aggregate shall comply with the requirements in Table 3 of BS 882 for single sized aggregates to the nominal maximum size specified for the appropriate class of concrete and shall be made up of the following gradings:

- a) 40mm single sized
- b) 20mm single sized
- c) 10mm single sized

The shape of the aggregate shall be rounded, or irregular as defined in BS 812: Part 1. The flakiness index, as determined in accordance BS 812: Section 105.1, shall not exceed 35 and the 10% fines value, as determined by BS 812: Part 111, shall be greater than 50kN.

The water absorption of aggregates to be used for class C35A concrete for water retaining structures shall not exceed 3% when measured in accordance with BS 812: Part 2.

The soundness of the aggregate, as determined in accordance with ASTM C 88-83 using magnesium sulphate with 5 cycles, shall not show a loss of greater than 15% for fine aggregate and 18% for coarse aggregate.

Immediately after commencement of the Works, the Contractor shall supply samples of proposed aggregates for preliminary tests of compliance with Specification to the satisfaction of the Engineer before the Engineer will give approval to the source aggregates proposed by Contractor. Alternatively, and subject to the approval of the circumstances by the Engineer, the Contractor may submit a Certificate from an independent laboratory.

Where 40mm nominal maximum size coarse aggregate is specified it shall consist of a mix of 40mm single sized aggregate, 20mm single sized aggregate and 10mm single sized aggregate.

During the performance of the Contract, the Contractor shall supply samples of aggregates when required by the Engineer for testing (the samples shall be taken in accordance with BS 812). Testing of all specified requirements will be performed by the Contractor at intervals as directed by the Engineer for each source at each grading approved by the Engineer, unless otherwise instructed by the Engineer. Any rejected aggregate shall be promptly removed from Site.

The Contractor shall demonstrate that no part of the aggregates contain any mineral known to have a potential to cause alkali silica, alkali silicate, alkali carbonate or any other damaging chemical reaction between alkalis and aggregates. Testing of aggregates shall be accordance with ASTM C1260-94 and ASTM C586 as appropriate.

Should the results of the tests prove unsatisfactory the Contractor shall make provision for the employment of a low alkali content cement to the approval of the Engineer.

2.4 Water

The water used for making and curing concrete, grout and mortar shall be from a source approved by the Engineer and at the time of use shall be free from polluting matter in any quantity which.

- a) Affects the initial setting time of the cement by more than 30 minutes or reduces the compressive strength of test cylinders by more than 20% when tested in accordance with BS 3148;
- b) Prevents the achievement of the specified test cylinder strengths at 28 days for the appropriate class of concrete;
- c) Produces discoloration or efflorescence on the surface of the hardened concrete.

The water shall be free from hydrocarbons and from suspended organic matter. Inorganic matter in solution shall not exceed 500mg/l by weight and in suspension shall not exceed 50mg/l by weight.

No salty water shall be used.

The water which the Contractor proposes shall be tested by the Contractor to the approval of the Engineer before use in the Permanent Works.

Regular tests of the water shall be made by the Contractor during construction of the Works. The water shall be sampled at the point of discharge into the mix and the frequency of sampling shall be as approved by the Engineer. The Contractor shall supply two copies of each test result to the Engineer.

2.5 Admixtures

Admixtures in general shall comply with BS 1014, BS 3892 or BS 5075 as appropriate. Concrete shall be made from cement, aggregates and water as specified. No other ingredient shall be mixed with the concrete or mortar without the Engineer's approval.

If the Contractor proposes to use retarding or workability agents then the manufacturer's literature must be supplied giving typical dosage, effects of incorrect dosage, the amount of air entertainment associated with its use, and the chloride ion content by weight of the admixture. The Engineer's approval to the use of admixtures shall be subject to the following conditions.

- a) No reduction of target mean strength compared with additive-free concrete of the same class.
- b) No change in specified cement content or effective water cement ratio.
- c) No corrosive effect on reinforcement steel.

- d) Dosage and admixture must be strictly in accordance with the manufacturer's instructions in respect of the specific conditions pertaining. Dosage to be by an approved dispenser, to within 5% of the required amount.

If air entertainment is approved the air content shall be 4% for concrete with a maximum aggregate size of 40mm and 5% for concrete with maximum aggregate size of 20mm, with an allowable tolerance of 1.5%.

The method of determining the air content shall be in accordance with BS 1881: Part 106 and the Contractor shall supply the necessary apparatus so that the Engineer may check the air content. If the average air content is greater or less than that specified or the range is greater than 2%, before any further concrete is used in the Works the Contractor shall take such steps as may be agreed with the Engineer to adjust the air content of the concrete or improve its uniformity. Any rejected air entrained concrete must be removed.

2.6 Chemicals in Concrete Materials

The total sulphate content, whether as gypsum or more soluble salts, of concrete ingredients when measured as sulphur trioxide shall together not exceed 4.0% of the weight of cement in the concrete.

The chloride content of concrete ingredients when measured as Cl shall together not exceed 0.3% of the weight of cement in concrete using SRPC.

The sulphate and chloride contents shall be established using the following tests:

	Sulphate	Chloride
Aggregate	BS 1377 : Part 3	BS 812: Part 117
Cement	BS 4550 : Part 1 Clause 12	BS 4550 : Part 2 Clause 17
Water	BS 1377 : Part 3	BS 812 : Part 117

The contribution of any admixture must also be included. Testing will be weekly, or as directed by the Engineer. When the acid soluble alkali content of the cement is greater than 0.6% (calculated as $\text{Na}_2\text{O} + 0.658\text{K}_2\text{O}$) the Contractor must demonstrate that no adverse alkali-silica reaction is likely. This may be done by determining the alkali content of cement, in accordance with BS 4550: Part 2 and establishing the alkali content of the concrete. Any concrete containing less than 3.0Kg/m³ may be considered not at risk. In the event of higher alkali contents a sample of aggregate from each source must be tested in accordance with ASTM C 227-87. Any aggregate source showing an expansion greater than 0.05% at 3 months shall not be approved.

2.7 Damp proof course

The work shall consists of furnishing and lying Damp Proof Course with cement concrete (1:3) including two coats of hot bitumen with polythene sheet between for all the works.

Damp Proof Course of thickness show on the drawing or specified elsewhere with 1:3 cement concrete mixed with 2Kgs of pudlo per bag of cement bitumen with polythene sheet of 500 gauge in between shall be used. Pudlo shall be the genuine well known manufactured product used as a water proofing material. The material shall be best quality available and shall be subject to the approval of the Engineer before use.

Pudlo shall be well mixed with cement in dry state.

The work shall be carried out as per direction of the Engineer and relevant British Standard was applicable.

2.8 Reinforcement

Reinforcement shall be hot rolled Type 2 Grade 460 deformed high yield steel bars, and shall comply with BS 4449 – Yield stress minimum 460N/mm².

Steel fabric reinforcement shall comply with BS 4483.

The Contractor shall supply the Engineer with certificates of the manufacturer issued in accordance with Appendix C of BS 4449 or Clause 11 of BS 4483 for all the required tests including the rebend test in respect of each consignment delivered to Site. The Engineer may require the contractor to submit samples of steel from each delivery to an approved Authority for testing, the costs of all samples and tests shall be deemed to be included in the contractor's rates for reinforcement.

The reinforcement at the time of incorporation in the Permanent Works shall be clean and free from damage, oil or grease, paint, loose mill scale and loose rust. Bars which have become bent shall not be straightened or rebent for incorporation in the Works without the approval of the Engineer.

Steel reinforcement shall be stored clear of the ground and supported to prevent distortion. The Contractor shall supply samples of reinforcement from the stocks on Site when required by the Engineer.

2.9 Reinforcement Details

The Contractor shall be responsible for preparing bar bending schedules and any additional details required to fully describe the fixing of the reinforcement, checked and approved by the Engineer.

2.10 Waterstops

The Contractor shall supply and fix waterstops in all contraction and expansion joints in members which are to be liquid retaining and where shown on the Drawings.

They shall be obtained from manufacturers approved by the Engineer and shall be stored and fixed in accordance with the manufacture's instructions.

PVC waterstops shall comply with Information and Guidance Note 4-31-02 of the UK Water Research Centre.

The number of joints made on Site shall be kept to a minimum. Any jointing of PVC waterstops on Site shall be by the process of heat fusion using an appropriate jig and heating blade all in accordance with the manufacturer's recommendations.

The minimum dimensions of water-stops shall be as tabulated below (all dimensions in mm):

Width	Web Thickness	Edge Bulb* diameter	Centre Bulb* Int. diameter	Edge Bulb* height
140	4.5	12.5	8	-
190	4.5	12.5	8	-
240	4.5	19.0	10	22

Notes: * Internal waterstop only

** External waterstop only

Unless otherwise shown on the Drawings, the width of the waterstop shall be at least equal to the thickness of the concrete member in which it is embedded, up to a maximum width of 250mm.

The edge bulb section of internal waterstops shall be circular or semicircular. The centre bulb should be hollow.

The waterstop shall be carefully maintained in the position shown on the Drawings and properly protected from damage and the harmful effects of light and heat during all stages of construction. The stop-boards on each side of the waterstop shall be accurately wrought to match the profile of the waterstop. The concrete shall be carefully compacted under and around the waterstop so as to leave no cavities.

The Contractor shall supply the manufacturer's test certificates for each consignment of waterstop delivered to Site and shall if requested supply to the Engineer sufficient samples of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate standard test procedure.

The PVC for PVC waterstop shall be high grade virgin polyvinyl chloride containing no filler, reclaimed or scrap material. It shall comply with the requirements of BS 2571 for type A3 of Class 1 but shall have improved tensile qualities. The minimum tensile strength shall be 12.5 N/mm² and the minimum elongation at break shall be 28.5%.

2.11 Joint Filler

The Contractor shall supply and fix pre-moulded joint fillers in all expansion joints and where shown on the Drawings. Unless otherwise specified the joint filler shall be of resin or bitumen bonded cork or impregnated fibreboard. Impregnated fibreboard shall not be used in water retaining structures. Material shall be obtained from manufacturers approved by the Engineer and shall be stored and fixed in accordance with the manufacturer's instructions. The joint filler of the material and thickness specified shall be cut to shape and fixed to fill the whole space between the concrete faces to the joint not otherwise filled by waterstop and joint sealer. Abutting pieces shall be placed in close contact and the joints covered on each side to prevent the passage of cement grout.

The Contractor shall supply the manufacturer's test certificate for each consignment of each type of joint filler delivered to site and shall if requested supply to the Engineer sufficient samples of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate standard test procedure.

The filler shall comply with the following American Society for Testing and Materials Specification:

- | | | |
|----|---|------------------------|
| a) | Resin Bonded Cork | ASTM D 1752-84 Type II |
| b) | Bitumen Bonded Cork and
Impregnated Fibreboard | ASTM D 1751-83 |

2.12 Joint Sealers

All joints of concrete members shall be sealed with mastic as specified and/or as directed by the Engineer.

The Contractor shall select permanent elastic, synthetic mastic sealing compound, which has a high degree of extensibility, optimum elastic force and good adhesion to concrete. Products consisting of one or two components, on the basis of polysulphide liquid polymer, silicone rubber and polyurethane or others may be used; however, only proprietary materials (made by fully recognised manufacturers), which are resistant to aging, oxygen, irradiation with ultra-violet light, water, oil, grease, chemicals and biodegradation and which have been approved by the Engineer may be used.

Concrete grey mastic shall be used for joints in exposed concrete areas. Joints in concrete areas not exposed to the eye may be filled with dark coloured mastic.

The mastic shall be stored in sealed containers in a dry and cool place prior to use, strictly in accordance with manufacturer's instructions.

Mastic sealing compound used for expansion joints in water tanks shall be:

- Physiologically absolutely safe, i.e. it shall not contain any substances which may be considered a substrate for water bacteria;
- Resistant to any detergents used in water tanks;
- Complying with the health requirements for potable water.

The Contractor shall construct recesses at all joints and on both faces of the concrete work except on the underside of ground slabs. The recesses shall be accurately formed to the lines and dimensions shown on the Drawings or as agreed with the Engineer.

The Contractor shall prepare the surfaces of the recess and shall supply a joint sealer and fill or caulk the recess completely with it.

Joint sealing shall not be commenced without the approval of the Engineer. In reservoir joints the sealer shall be poured after the construction of the reservoir roof.

All joint sealers shall be from an approved manufacturer. The Contractor shall supply the manufacturer's test certificates for each consignment of each type of joint sealant delivered to the Site and shall if requested supply to the Engineer sufficient samples of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate test procedure.

Sealants shall be installed in strict accordance with the manufacturer's instructions. Debonding strip shall be used in conjunction with the sealers as indicated on the Drawings. The debonding strip shall be compatible with the joint sealer and shall be resistant to attack from the primer used to bond the sealer to the concrete.

Polysulphide and polyurethane sealers shall not abut bituminous sealers. Surfaces to receive polysulphide and polyurethane sealers shall be kept free from bituminous paints.

All sealers shall be appropriate for the prevailing climatic conditions.

Bituminous sealers shall comply with BS 2499 for Type A1.

Polysulphide sealers shall comply with BS 4254.

2.13 Bond Breaking Compound

Bond breaking compound shall consist of 66% of 200 pen bitumen blended hot with 14% light creosote oil and when cold brought to the consistency of paint by the addition of 20% solvent naphtha or other approved compound meeting the following requirement.

- a) It shall not retard or in any other way affect the setting of concrete.

- b) The average bond stress on bars coated with the compound with half their length cast into concrete specimens and subjected to pull out tests at 7 days shall not exceed 0.13 N/mm² and the total movement of the dowel bar relative to the concrete specimens shall be not less than 0.15mm at that stress. The concrete specimens shall be 150mm x 150mm in section and 450mm long and made with the same mix proportions as used in the works.

2.14 Classes of Concrete – General

The class of concrete is defined by the characteristic cylinder crushing strength and the nominal maximum aggregate size, with additional suffix defining any additional requirements. The requirements for each class of concrete are given in Table 2.1.

The specified slump values are a guide only and may be varied subject to the approval of the Engineer.

The concrete grade is defined as the 28 day cylinder crushing strength (MPa) below which no more than 5% of results are expected to fall.

TABLE 2.1
Concrete Classes

Concrete Class	Grade (MPa)	Maximum Aggregate Size (mm)	Cement* Type	Workability**
28/40	28	40	OPC	Medium
28/20	28	20	OPC	High
28/10	28	10	OPC	High
28/40S	28	40	SRPC	Medium
28/20S	28	20	SRPC	High
21/20	21	20	OPC	-
21/20S	21	20	SRPC	-
C15/40	15	40	OPC	-

Notes: * SRPC shall be used where specified in Clauses 2.19 and 2.21
 ** High workability: slump 65 to 135mm
 Medium workability: slump 50 to 100mm

2.15 Classes of Concrete – Particular

The classes of concrete to be used are as noted on the Drawings. In addition, the following shall apply unless specified otherwise:

- 28/20S - Reinforced concrete in foundation and plinth, reservoirs and chambers (if required)
- 28/20 - Reinforced concrete in foundation and plinth, reservoirs and chambers
- 21/20 - Reinforced concrete in super structures above plinth

	- Precast concrete
21/20	- Benching to manholes and chambers. - Carriageways and footpaths
21/20S	- Pipe bedding and pipe anchor Support blocks & filling with mass concrete.
15/20	- Blinding / Lean Concrete - Non-structural concrete around manholes & chambers. - Haunching to kerbs.

All concrete or mortar used in sewerage manholes, chambers or tanks shall be made with SRPC.

2.15.1 Classes of Concrete by Proportion (Volume) – Particular

The following classes of concrete shall be interchangeably used:

C - 13 is equivalent to 1:4:8 cement concrete (1 part Cement: 4 part Sand and 8 part Concrete)

C - 21 is equivalent to 1:2:4 cement concrete (1 part Cement: 2 part Sand and 4 part Concrete)

C - 25 is equivalent to 1:1.5:3 cement concrete (1 part Cement: 1.5 part Sand and 3 part Concrete)

2.16 NOT USED

2.17 Water-Retaining Concrete

Where waterproof concrete is required, the Contractor shall take full responsibility for ensuring that such construction is completely waterproof (crack-free). Any leaks appearing during the construction and maintenance period of the Contract shall be completely repaired by the Contractor at his own expense. The method proposed by the Contractor for dealing with shrinkage cracks, leaks, or other defective work shall have no adverse effect on the finished structure. Treatments of internal and external concrete surfaces of water retaining structures, etc. (coatings or toppings) provided in the Bill of Quantities, does not relieve the Contractor of this obligations under the Contract. These treatments shall be considered as an additional step for waterproofing and/or resistance to chemical attack.

2.18 Concrete Mix Design

The Contractor shall determine to the approval of the Engineer the actual proportions of ingredients for each class of concrete to be used in the permanent works.

The concrete shall meet the requirements given in Table 2.2(a).

Before commencing any concerning on the Site the Contractor shall conduct tests to the satisfaction of the Engineer to determine the concentration of sulphate in the soil and the ground water in order to determine the concrete exposure class as detailed in Table 2.2(b), . The Contractor shall ensure that all concrete susceptible to sulphate attack from the soil and ground water shall be designed to satisfy the additional requirements given in Table 2.2(b) for the particular Site exposure class.

TABLE 2.2(a)**Requirements of Classes of Concrete**

Class	Cement Content kg/m ³		Maximum W/C ratio
	Minimum	Maximum	
28/40	245	550	0.65
28/20	275	550	0.65
28/10	315	550	0.65
28/40S	250	550	0.65
28/20S	285	550	0.65
21/20	270	550	0.55
21/20S	280	550	0.55
15/20	220	550	0.60

- Notes: 1** Water cement ratio is the ratio of free water to cement in the mix based on aggregates being in a saturated surface dry condition.
- 2** Characteristic compressive strength compliance requirements shall be to BS 5328 Clause 3.16.2 and Table 1.

TABLE 2.2 (b)

**Requirements of Classes of Concrete
Exposed to Sulphate Attack**

Class	Concentration of sulphare expressed as SO		Type of Cement	Dense fully compacted concrete made with 20 nominal size aggregate complying with BS 882 or BS 1047	
	In Soil			In Groundwater (g/litre)	Cement* Content not Less than
	Total SO3	SO3 2:1 Water: soil Extract (g/litre)			

1	Less than 0.2	Less than 1.0	Less than 0.3	All cements listed in Clause 6.1, 2.1** BS 12 cements combined with pfa* BS 12 cements Combined with ggbfs+	No additional requirements	
2	0.2 to 0.4	1.0 to 1.5	0.3 to 0.7	All cements listed in Clause 6.1, 2.1** BS 12 cements combined with pfa* BS 12 cements Combined with ggbfs+	330	0.50
				BS 12 cements Combined with min 25% or max 40% pfa + + BS 12 cements Combined with min 70% or max 90% ggbfs	310	0.55
				BS 4027 cements (SRPC) BS 4248 cements (SSC)	280	0.55
3	0.4 to 0.7	1.5 to 2.1	0.7 to 1.4	BS 12 cements Combined with min 25% or max 40% pfa + BS 12 cements Combined with min 70% or max 90% ggbfs	380	0.45
				BS 4027 cements (SRPC) BS 4248 cements (SSC)	330	0.50
4	0.7 to 1.0	2.1 to 3.1	1.4 to 2.5	BS 4027 cements (SRPC) BS 4248 cements (SSC)	370	0.45
5	Over 1	Over 3.1	Over 2.5	BS 4027 cements (SRPC) and BS 4248	370	0.45

				cements(SSC) with adequate Protective coating. Refer Clause 6.2.3.3 **		
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- Note: * Inclusive of pfa and ggbfs content.
 ** All Clause numbers refer to BS 8110.
 + Refer to BS 8110, Clause 3.3.5
 ++ Values expressed as percentages by mass of total contents of cement. Pfs and

1. Mix proportions shall be adjusted in accordance with BS 8110, Clause 6.2.4.3
2. Reference should be made to the notes given with Table 6.1 in BS 8110 retaining to use of sulphate-resisting Portland cement (SRPC) and the method analysis of soil water extracts.
3. SSC – Supersulphated cement.

Unless otherwise specified or agreed by the Engineer for concrete Grade 30 and above the proportions of coarse and fine aggregates shall be selected to achieve one of the grading curves defined in Table 2.3, within an allowable tolerance of generally 5%. A change from a maximum positive tolerance to a maximum negative tolerance in consecutive sieve sizes should be avoided. Classes 20/40P and 20/40SP shall have a fine aggregate content of 15% of the coarse aggregates.

TABLE 2.3
Combined Aggregate Gradings
40mm maximum aggregate size grading curves

Sieve size (mm)	1	2	3	4
50	100	100	100	100
37.5	95	97	99	100
20	50	59	67	75
10	36	44	52	60
5	24	32	40	47
2.36	18	25	31	38
1.18	12	18	24	30
0.60	7	12	17	15
0.30	3	7	11	15
0.15	0	0	2	5

20mm maximum aggregate size grading curves

Sieve size (mm)	1	2	3	4
37.5	100	100	100	100
20	95	97	99	100
10	45	55	65	75
5	30	35	42	48
2.36	23	28	35	42
1.18	16	21	28	34
0.60	9	14	21	27
0.30	2	3	5	12
0.15	0	0	0	1.5

10mm maximum aggregate size grading curves

Sieve size (mm)	1	2	3	4
10	95	97	99	100
5	30	45	60	75
2.36	20	33	46	60
1.,18	16	26	37	46
0.60	12	19	28	34
0.30	4	8	14	20
0.15	0	1	3	6

The Contractor shall submit details of the source of all material and the proposed quantities of each ingredient per cubic metre of fully compacted concrete. The Contractor shall then make trial mixes for each class of concrete using the same type of Constructional Plant and the same materials as are proposed for the Permanent Works. The Contractor shall give 24 hours notice of such trials to enable the Engineer to attend. For each trial mix, three separate batches of concrete shall be made by the Contractor and will be tested at 28 days all in accordance with BS 1881: Part 116. Such trial mixes shall not be the first batch through the plant in any one sequence of concrete production.

The Contractor shall not commence concreting in the Permanent Works until details of trial mixes and test results for each class of concrete have been submitted to, and approved by, the Engineer.

A trial mix design will be approved by the Engineer with respect to strength if the average compressive strength of the nine cylinders so tested is more than the target mean strength appropriate to the class as given in Table 2.2(a).

The Contractor shall not alter the approved mix proportions nor the approved source of supply of any of the ingredients without having previously obtained the approval of the Engineer.

During production the Engineer may require trial mixes to be made before a substantial change is made in the materials or in the proportions of the materials to be used.

2.19 Delivery and Storage of Materials

All materials for concrete delivered shall be approved and contain following identification marks both in English and Urdu and stacked as per instruction of the Engineer.

- type of cement/steel
- number and date of standard conforming to
- net weight of cement contained in bags
- name, trade name of manufacturer
- country of origin
- date of manufacture

2.20 Control and Mixing of Ingredients

The Contractor shall measure the moisture content in the aggregates and so determine the amount of water to be added to each batch of fresh concrete. Such determinations shall be to the approval of the Engineer and the results and calculations shall be available for inspection by him. The frequency of such determinations shall be as directed by the Engineer and shall depend on the quality of control of storage and handling, weather conditions and variability of aggregate supplied.

The Contractor shall proportion the ingredients of each batch of concrete by weight. The measuring equipment should give an accuracy of + 3 % for each ingredient. The Water shall be added to the aggregates and cement in a mechanical batch mixer; it shall not exceed the maximum ratio with regard to cement given in Table 2.2 (a) hereof, and shall otherwise be the minimum amount necessary consistent with complete compaction. The device for measuring the water shall show accurately the weight required with a given moisture content of the aggregate and shall be so designed that the water supply will be automatically stopped when the correct quantity has been discharged into the mix. The concrete ingredients shall then be thoroughly mixed.

The minimum mixing time shall be:

- i) For mixes of 1.5m³ capacity or less 1-1/2 minutes.
- ii) For mixes of larger capacity than 1.5m³ the time shall be increased by 15 seconds for each additional 0.75m³ capacity. For intermediate sizes the time shall be assessed by proportion.

In special circumstances, and at the sole discretion of the Engineer, the proportioning of materials by volume may be approved. In such circumstances the cement content of the concrete shall be increased by 10% over the amount in the approved mix. The boxes used for proportioning shall be deep and narrow to the approval of the Engineer, and shall be separately constructed for each class of concrete to be proportioned by volume.

2.21 Concrete Sampling and Testing

The temperature of concrete, concrete constituents, reinforcement form work and the atmosphere shall be monitored continuously for every concrete pour. All sampling and testing of fresh and of hardened concrete shall be carried out in accordance with the provision of BS 1881 unless such provision is at variance with the Specification.

Table 2.4 gives the program for sampling and testing of concrete for each class of concrete from each batching centre in each active day.

TABLE 2.4
Program for Works Sampling and Testing

Grade	30 & above	Less than 30
Workability (slump test)	1	0
Workability (compacting factor test)	2	0
Compressive strength	3	0

- Where:
- 0 - no testing required
 - 1 - every batch at point of deposit
 - 2 - one sample from every 10 batches, one sample per 20m³ of concrete or one sample from each day's concrete, whichever involves the greatest number of samples.
 - 3 - One sample from every 50 batches, one sample per 50m³ of concrete or one sample from every three days concrete, whichever involves the greatest number of sample.

The Contractor shall establish a plan for sampling and testing to the approval of the Engineer. Samples shall be taken at the place of deposition from each class of concrete at random. The frequency of sampling shall in general be in accordance with Table 7.4, but the actual rate of sampling may vary with the approval of the Engineer and shall be increased when ordered by the Engineer in appropriate circumstances. From each such sample six 150mm concrete cylinders shall be prepared; each cylinder shall be marked indelibly for identification when it is in the mould. After retention at the site for 24 hours the cylinders shall be delivered to the testing laboratory for curing and testing.

2.22 Compliance with Specified Concrete Requirements

Of the six cylinders made from each sample of fresh concrete in accordance with the Specification, three will be crushed at 7 days and the other three at 28 days. The average of the three 28 days strengths will be taken as the test result. Compliance with the specified strength requirements shall always be judged on the 28 days test results.

Concrete shall be considered to have failed to comply with the Specification:

- (a) If a test result is less than the minimum specified in BS 5328 for that class of concrete, in which case the concrete which it represents shall be broken out and disposed of away from the site by the Contractor unless at his sole discretion the Engineer approves otherwise (Ref Table 2.2(a)).

- (b) If the average of four consecutive test results for that class of concrete shall have failed to exceed the minimum mean of 4 as specified in BS 5328 in which case no further concrete of that class shall be placed in the Permanent Works until the Contractor shall have discovered the cause of such failure and rectified it to the satisfaction of the Engineer (Ref Table 2.2 (a).

If a mix fails to achieve the requirements for fresh concrete the batch shall be rejected and no further concrete of that class shall be placed in the Permanent Works until the cause of failure has been rectified.

If test results for strength of concrete of any class are consistently and significantly in excess of the target mean strength the Engineer may on the application of the Contractor agree to a reduction in the cement content in the mix for that class, provided the cement content is not lowered below the minimum specified for that class, nor the maximum water/cement ratio exceeded.

2.23 Further Testing

When the Engineer agrees to or requires testing of the hardened concrete in a structure or precast element all such testing shall be carried out in accordance with BS 1881 or BS 8110. The results of such tests shall be interpreted in accordance with BS 6089. Any test on hardened concrete required by the Engineer shall be completed within 28 days of the Engineer's order for the test.

In assessing the results of compressive tests on cores the concrete represented by the core shall be deemed not to comply with the Specification if the strength of the core when adjusted for length: diameter ratio and converted to estimated cylinder strength in accordance with BS 1881 is less than 85% of the specified characteristic strength. Cores shall not be tested for strength at ages less than 28 days and no adjustment shall be made to the measured strength in respect of the age of the core when tested.

2.24 Transporting, Placing and Compacting Concrete

The concrete shall be handled so that at the point of deposition it is of the specified quality and approved consistency, nothing having been added to it or lost from it since leaving the mixer. Any free water shall have been removed from the section to be concreted before concrete is deposited.

The Contractor shall obtain the approval of the Engineer to the arrangements he proposes to use for concreting before commencing concrete work.

The Contractor shall regard the compaction of the concrete as work of fundamental importance and shall produce a watertight concrete of maximum density compatible with the approved mix. Compaction shall be assisted by the use of mechanical vibrators of the immersion type, but shall not involve the vibration of reinforcement or shutters except that vibration of shutters may be allowed in precast concrete, with the approval of the Engineer. Vibrators shall be inserted at least to the full depth of the newly deposited concrete, kept in position for about a quarter of a minute and then slowly withdrawn to prevent the formation of voids. The procedure shall be continuous with points of

insertion 150 to 225mm apart. The number and type of vibrators available for use during each period of concreting shall be to the approval of the Engineer, which will not be given if sufficient stand by vibrators in good working order are not readily available. If concreting is in the dark, ample lighting shall be provided at the mixing stations and at every place where concrete is being deposited.

Lean concrete for blinding course may be compacted by tamping.

Concrete without a retarder which is not deposited in the work within 30 minutes after the start of mixing shall not be used unless the Engineer approves otherwise.

Concrete may be pumped provided the mix design and the nature of pumping comply with the recommendations given in the Guide to Concrete Pumping as published by the Building Research Establishment (UK) and are not in conflict with any specified requirements.

The first batch of concrete to be made every time work is commenced shall contain 10% more cement than the normal amount.

Concrete shall be placed continuously up to positions of joints prepared prior to commencement of concreting. No concrete shall be dropped or chuted into the shuttering in such a manner as to cause segregation of the ingredients. The deposited layers of concrete shall not exceed 600mm in thickness. Shallow beams may be concreted to full height in one operation as directed by the Engineer. Care shall be taken to ensure that reinforcement projecting from concrete recently placed is not shaken or disturbed.

Where steps, splays and kickers occur these shall be cast in one with the slab and additional care shall be taken in the vibration and finishing techniques and procedures to ensure that thorough compaction is achieved and the unset concrete is not subjected to tension and no cracks are formed. The techniques and procedures to be adopted shall be discussed with the Engineer and his approval received before any such concreting is commenced.

7.25 Truck Mixed Concrete

Truck mixers can be used if authorised by the Engineer. They shall be of the revolving type, watertight and so constructed that the concrete can be mixed to ensure a uniform distribution. When truck mixers are approved to supply concrete to a distant location, the Contractor shall ensure that the following information is supplied on an approved delivery form:

- Type of concrete and ingredients used;
- Water/cement ratio;
- Type and quantity of approved additives to the concrete mix;
- Time of departure from batching plant;
- Slump;
- Signature of plant manager.

Water shall be added to the mix either at site or at the batching plant. In no circumstances shall water be added in transit.

No concrete shall remain in a revolving truck mixer more than 1 ½ hours.

2.26 Concreting in Unfavourable Conditions

The Contractor shall not place concrete in the Permanent Works:

- a) During heavy rains or dust storms.
- b) When the air temperature is more than 40o C.
- c) When the air temperature is less than 2oC.
- d) If the temperature of the concrete on discharge from the mixer is less then 4o C or more than 32oC.
- e) When the air temperature exceeds 25°C without taking precautions and demonstrating to the approval of the Engineer that the maximum internal temperature of the concrete within 24 hours after casting in place is unlikely to be more than 30°C in excess of the ambient temperature or more than 60°C.
- f) Without the approval of the Engineer if the temperature of the shutters or reinforcement exceeds 30°C.

To keep within these limits the Contractor may, among other means, spray aggregates with water, and use chilled mixing water, or add ice direct to the mixer provided that no ice is present in the mix when discharged from the mixer.

When concreting in hot weather all material used shall be kept in the shade. Water tanks, mixers and chutes should be shaded, but where this is not possible they shall be painted white and kept white.

2.27 Concreting Records

A written record of the concrete works shall be made each day by the Contractor and kept available for inspection by the Engineer. The diary shall contain notes and records of:

- a) The names of the Contractor's engineers who are responsible for the different phases of the concrete work, and also the names of their assistants.
- b) The temperatures of air, water, cement, aggregates and concrete, together with the air humidity and type of weather.

- c) Deliveries to the site of concrete materials (quantity, brand of cement, etc).
- d) Inspections carried out, tests performed, etc and their results.
- e) Times of commencement and completion of different parts of the concrete works, and times of creation and striking of forms.
- f) Quantity of cement, fine and coarse aggregate and admixture used for each section of work, and the number and kind of test samples taken on these ingredients and water.

2.28 Shuttering

The terms shuttering and form work shall be interpreted as meaning one and the same thing, namely Temporary Works set up to obtain the required profiles and surface textures of the concrete. Shuttering shall be such that it remains rigid during the placing and setting of the concrete and prevents the loss of any concrete ingredients.

The shuttering shall be fixed in correct alignment and to the true shape and dimensions of the Permanent Works and shall be designed so that it can easily be removed for curing of concrete to commence as soon as practicable. Where necessary, shuttering should be so arranged that the soffit form, properly supported on props only, can be retained in position for such periods as may be required to allow the concrete to mature as specified in Clause 2.44. A method of support which would involve holes or tie wires extending the whole width from face of work to be concreted will not be permitted, unless authorised by the Engineer in writing. No plugs, bolts, wire ties, holdfasts or any other appliance whatsoever for the purpose of supporting the shuttering or reinforcement shall be fixed permanently into the structure so that they have less cover than that specified for the reinforcement or in any way impair the strength or appearance of the work, nor shall they be placed in such a manner that damage to the work would result in the removal of the same at the time of striking the shuttering.

Before the concrete is placed the retaining surfaces shall be cleaned of sawdust and shavings, dirt, other debris and standing water.

The inside of shuttering shall be coated with a release agent of non-staining mineral oil, mould cream emulsion or with other approved material. Adjacent concrete or reinforcement shall not be contaminated. The release agent must be compatible with any applied finish.

Temporary openings for cleaning and inspection before concreting shall be provided at the base of column and wall shuttering and where necessary. Shuttering for walls or other thin sections may have openings where approved by the Engineer for the placing and compacting of the concrete.

No concreting shall be started before the shuttering has been inspected by the Engineer. Unless otherwise approved, top shuttering shall be provided to concrete faces where the slope exceeds one vertical to three horizontal. Exposed arises shall be formed with a chamfer measuring 20mm x 20mm.

The rates for concreting shall include shuttering and for all types of cutting and waste, forming chamfers or as otherwise indicated on the Drawings.

2.29 Surface Finishes

The faces of all concrete shall be left sound, solid, free from voids and to the class of finish specified.

No treatment to the finished concrete other than that specified in the class of finish shall be carried out unless approval to do so has been given by the Engineer.

Bolt bobbin holes shall be filled with cement and suitable fine aggregate mortar to match the colour of the concrete. The mortar shall be well worked in and thoroughly cured.

Classes for formed surfaces:

Class F1 – This finish requires no special treatment and is for surfaces which will remain hidden in the Permanent Works.

Class F2S – This finish is for all exposed surfaces that shall not be rendered. The finish shall be obtained from forms designed to produce a hard smooth surface with true, clean arises. Only very minor surface blemishes shall be permitted and these shall be no staining or discoloration. The formwork shall be faced with plywood or equivalent material in large sheets rigidly supported so as to prevent distortion under load. The sheets shall be arranged to coincide with architectural features, or changes in direction of the surface. All joints between panels shall be straight and either vertical or horizontal unless otherwise directed and the joints between panels to slab soffits shall be parallel to the supports. Suitable joints shall be provided between sheets to minimise joint marks and to maintain accurate alignment in the plane of the sheets.

Class F2R – This finish is for all exposed surfaces that are to be rendered or plastered. The formwork shall be face with plywood or equivalent material in large sheets rigidly supported so as to prevent distortion under load. All joints between panels shall be straightened either vertical or horizontal unless otherwise directed. Suitable joints shall be provided between sheets to minimise joint marks and to maintain accurate alignment in the plane of the sheets. The surface of the formwork shall be unplanned so as to produce a rough concrete finish to provide a good key for the render or plaster.

Class F3 - This finish is identical to Class F2 finish except that the permitted deviations for irregularities are more stringent as given in Table 2.5.

Profiled Surface Finish – This finish is used where indicated on the Drawings. The quality of the surface finish and the permitted deviations shall be as for a Class F2S finish.

Where a surface is partly below and partly above the final ground level the finish for exposed surfaces shall extend for 500mm below the final ground level.

Classes for unformed surfaces:

Type U1 - This finish is for surfaces where a superior finish is not required. It is also the first stage for finishes U2 and U3. The finishing operations shall consist of grading, tamping and screeding the concrete to produce a uniform, plain or ridged surface.

Type U2 - This is a smooth matt finish such as may be achieved by a wood trowel, as required, inter alia, to receive mastic pavings, block or tile pavings bedded in mastic or screeds. Smoothing shall be done only after the concrete has hardened sufficiently, and may be by hand or machine. Care shall be taken that the concrete is worked no more than is necessary to produce a uniform surface free from marks.

Type U3 - This a smooth steel-trowelled finish for surfaces of concrete pavings, tops of walls, coping's and other members exposed to weathering or water, surfaces to receive thin flexible sheet, tile pavings bedded in adhesive, and seatings for bearing plates and the like where the metal is in direct contact with the concrete. Trowelling shall not commence until the moisture film has disappeared and the concrete hardened sufficiently to prevent excess laitance from being worked to the surface. The surfaces shall be trowelled by hand or machine under firm pressure and left free from trowel marks.

Type U4 - This is a power trowelled finish for surfaces to receive epoxy resin floor finish. Trowelling shall not commence until the moisture film has disappeared and the concrete hardened sufficiently to take the weight of the machine and operator.

2.30 Finishes for Formed Surfaces – Particular

Class F1 is for surfaces which will remain hidden in the Permanent Works.

Unless otherwise stated on the Drawings all exposed surfaces shall be Class F2R, subject to the following exceptions:

The internal faces of all liquid retaining structures shall be Class F2S.

The exposed faces of all concrete walls shall be Class F2S.

2.31 Permitted Deviations in Finished Work

The irregularities in formed and unformed surfaces for the various classes of finish shall be within the target limits shown in Table 2.5. If irregularities exceed the target the Contractor shall take the necessary steps to bring subsequent work within the target. If, however, the irregularities exceed the

maximum allowable shown in the table it shall be sufficient cause for the structure, member or section of a member of the structure to be removed and properly reconstructed.

In Table 2.5 the type of irregularity is defined as follows:

- i) Departure from alignment, and grade and dimension shown on the Drawings.
- ii) The cross-sectional dimensions of structural members less than 600mm, such as walls, columns, beams, etc where, for structural reasons, it is desirable to keep the tolerances within closer limits than those for alignment and grade.
- iii) Gradual irregularities measured from a 3m long template placed against the concrete.
- iv) Abrupt irregularities such as those resulting from defective or displaced facing or movement of supports.

TABLE 2.5
Permitted Deviations for
Irregularities of Concrete Surfaces

Tolerances in mm						
Formed finish						
Type Irregularity	Target			Maximum allowed		
	F1	F2	F3	F1	F2	F3
1	+ 20	+ 5	+ 1	+ 40	+ 10	+ 2
2	+ 07	+ 5	+ 1	+ 15	+ 10	+ 2
3	7	5	+ 1	15	10	+ 2
4	7	3	+ 1	10	5	+ 2

Tolerances in mm						
Unformed finish						
	U1	U2	U3	U1	U2	U3
1	+ 20	+ 10	+ 3	+ 35	+ 20	+ 6
2	+ 07	+ 5	+ 3	+ 15	+ 10	+ 6
3	10	5	3	20	10	6

2.32 Remedial Work

A concrete surface with in the opinion of the Engineer fails to achieve the required standard shall render that section of concrete, the member of which it is a part, or in extreme cases the whole structure, liable to be rejected by the Engineer.

No remedial work shall be started before the defective section has been inspected by the Engineer. If the Engineer permits remedial work as an alternative to reconstruction, the Contractor shall submit his proposals in respect of the repair to the Engineer for his approval.

Bolt bobbin holes shall be filled with cement and suitable fine aggregate mortar to match the colour of the concrete. The mortar shall be well worked in and thoroughly cured.

2.33 Fixing Reinforcement

Steel reinforcement shall be cut from straight bars free from kinks and bends or other damage, and cold bent by experienced competent workmen. Bars shall be bent in a bending machine approved by the Engineer. Cutting, bending and marking shall be to the tolerances and format given in BS 4466 unless otherwise specified or ordered by the Engineer.

The distance between any two parallel bars shall not be less than 5mm more than the nominal maximum size of aggregate in the concrete, except at approved laps. The length of lap shall be as shown on the Drawings or ordered by the Engineer.

The Contractor shall place and fix steel reinforcement accurately in the positions shown on the Drawings and shall ensure that it remains rigidly in that position during the placing of concrete. Tack welding shall not normally be permitted, however in particular cases it may be allowed with the prior approval of the Engineer. Supports, spacers, including PVC spacers, and ties shall be subject to the approval of the Engineer. Concrete spacers shall be made of the same quality concrete as that for the work in which they will be embedded with any tying wires galvanized and located to give a minimum cover of at least half that specified for the reinforcement. Metallic spacers, fixing clips and tying wire shall be compatible with the material of the reinforcement, and the specified cover shall be maintained.

Spacers should be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete.

Reinforcement projecting from previously cast concrete shall not be bent so as to require rebending without the prior approval of the Engineer.

The main wires of adjacent sheets of steel fabric reinforcement shall be lapped at least 300mm and the transverse wires at least 150mm.

The Contractor shall not place concrete around reinforcement until the reinforcement has been inspected by the Engineer.

2.34 Cover to Reinforcement

Except where otherwise shown on the Drawings the nominal concrete cover to the nearest reinforcement (exclusive of concrete blinding and rendering) shall be 40mm.

The actual concrete cover shall not differ from the nominal cover by more than + 5mm for bars up to and including 12mm size and +10mm for bars greater than 12mm size.

2.35 Construction Joints

Where construction joints are shown on the Drawings the Contractor will not be permitted to alter these joints or their positions or to increase their number without the prior approval of the Engineer.

Where not shown on the Drawings, the details and positions of construction joints shall be submitted to the Engineer for approval before any concreting takes place. They shall be located so that, when considered with the sequence of concreting, the effects of shrinkage and temperature are minimized.

Construction Joints shall be formed in straight lines with rigid shuttering perpendicular to the principal line of stress and as far as practicable at points of least shear. They shall be the plain type unless otherwise specified or approved.

As soon as the exposed concrete has sufficiently hardened surface of the joint shall be brushed with a stiff brush to expose the larger aggregate without it being disturbed. Roughening of the surface by chipping or hacking will not generally be approved. Before placing fresh concrete against a construction joint all loose material shall be removed and the surface sluiced with water until it is perfectly clean, thereafter all ponded water should be removed.

A period of at least 3 days and not more than 14 days, except under special circumstances and with the approval of the Engineer, shall elapse between the casting of successive lifts of concrete.

In the case of water retaining structures no more than 7 days will be permitted to elapse between casting of the base or footing to a wall panel and the casting of the stem of the wall on the base or footing.

The cost of construction joints shall be deemed to be included in the rates for concrete.

2.36 Movement Joints

Movement joints (Expansion & Partial Contraction joint) shall be constructed in the positions as shown on the Drawings or as directed or approved by the Engineer.

Movement joints are measured separately and items are included in the Bill of Quantities for the various joints in each of the structures.

Where indicated on the Drawings, dowel bars shall be positioned across the joint. They shall be placed with the midpoint of the longitudinal axes intersecting the plane of joint at right angles, half the length of the bars being suitably coated to prevent bonding. Fitted over the coated length shall be a pipe sleeve, closed and packed with compressible filler for a depth of 25mm at the end of the bar remote from the joint.

Where shown on the Drawings or as directed by the Engineer, joints shall be sealed on one or both faces as required. On the face or faces requiring sealing, a groove of the shape and dimensions shown on the standard joint details shall be formed. Not earlier than fourteen days after the placing of the concrete, or when otherwise directed by the Engineer, the groove shall be cleaned, dried if necessary, primed and filled with a suitable approved mastic sealing compound to the underside of the chamfers. The sealer shall be prepared and applied strictly in accordance with the manufacturer's instructions.

The joints shall be made by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint. The surface of the concrete first placed at contraction joints shall be coated with band breaking compound before the concrete on the other side of the joint is placed.

2.37 Protection and Curing of Concrete

The Contractor shall take measures to the approval of the Engineer for the protection of concrete from the harmful effects of wind, sun, high and low temperatures, rapid temperature changes, premature loading, deflection, impact and aggressive ground water. Such measures shall continue from the time that the concrete is placed for a minimum of 14 days.

All exposed concrete surfaces shall be kept moist, for not less than 14 days after casting by methods to be approved by the Engineer in writing before use.

Concrete surfaces shall be protected and cured in the following manner.

- a) The concrete shall be kept moist for a continuous period of at least 14 days after placing by covering it with moist sand, wet sacks, canvass, fibre mats or other satisfactory material capable of retaining the moisture, or by providing a sprinkler system.
- b) Utilizing of an approved non-bituminous pigmented liquid curing compound of an adequate type. The compound shall be applied strictly in accordance with the recommendations of the manufacturer. This compound shall not be applied on concrete surfaces of movement or construction joints.

2.38 Removal of Shuttering

Shuttering shall be removed in accordance with Table 2.6. In certain circumstances reductions may be made to these times in accordance with the principles of BS 8110: Part 1: Clause 6.9.3, with the prior written approval of the Engineer. Unless the soffit shuttering to beams and slabs has been designed so that it can be struck without disturbing the props, it shall be retained in position for the minimum period given in Table 2.6 for the retention of the props. Great care shall be exercised during the removal to avoid shocks to, or reversal of stress in, the concrete.

TABLE 2.6
Minimum Period Before Striking formwork

Temperature of Concrete	16o C	7oC
Type of formwork		
Vertical formwork to columns,		
Walls and large beams	18 hours	24 hours
Soffit formwork to slabs		
(props left under)	4 days	7 days
Props to slabs	11 days	14 days
Soffit formwork to beams		
(props left under)	8 days	14 days
Props to beams	15 days	21 days

Notwithstanding the foregoing the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

2.39 Cement Mortar

Mortar shall comply with BS 5628.

Sand shall be to BS 1200, Table 1, for general purpose mortars. Cement shall be as specified in Clause 7.2.

Plasticizers shall comply with BS 4887 and be used only as recommended by the manufacturer.

The dry ingredients of cement mortar shall be thoroughly mixed with just sufficient water to make it workable to the correct degree. With the approval of the Engineer anon-shrink admixture may be used subject to the provisions of Clause 2.6.

Cement mortar which has begun to set shall not be used or reworked for use in the works.

Mortar shall be mixed in a batcher mixer of a type approved by the Engineer or mixed by hand as instructed by the Engineer.

The proportions of mortar shall be:

- a) Type M1

Mortar for block work and building in ancillary components such as sills, coping's, lintels.

Cement: Sand 1:3

The proportion of sand may be increased to give a maximum cement: sand ratio of 1:5 provided that the workability of the mortar is maintained by the addition of an approved Plasticizer.

b) Type M2

Mortar for:

- bedding steel flooring system support angles;
- packing cavities between pipe work or embedded plant and the surface of structural concrete or block work;
- Packing under horizontal surfaces such as stanchions and machine baseplates;
- grouting of steel channels or support frames for switchboard and electrical equipment.

Cement: Sand 1:1

Leveling of the equipment before mortar packing, and checking of alignment before and after the grouting will be carried out by others.

Immediately before mortar packing, the space between the concrete and base plate shall be cleaned and thoroughly wetted. All excess water shall then be blown away by means of a compressed air jet.

2.40 Cement Grout

Cement grout shall be mixed in the relevant proportions indicated in the following table using the minimum quantity of water to ensure the necessary fluidity and to render it capable of penetrating the work.

Class	Nominate mix by mass	
	Cement	Sand
G1	1	-

The Contractor shall carry out the following grouting work as and when instructed by the Engineer, using the specified grout type:

- i, filling of pockets containing holding-down bolt anchorages or ragbolts: G1
- ii, Grouting of bolt tubes: G1

Leveling of the equipment before grouting, and checking of arrangement before and after the grouting will be carried out by others.

Grout shall be mixed in a batcher mixer of a type approved by the Engineer or mixed by hand as instructed by the Engineer.

Immediately before grouting, the grout pockets shall be cleaned and thoroughly wetted. All excess water shall then be blown away by means of a compressed air jet.

The grout shall be transported from the mixer to the placing point quickly and in such a way that the materials do not segregate. Grout shall be placed within 30 minutes of being mixed.

Grout shall be worked into position with rods or other suitable instruments until the whole of the space is completely filled with the grout. Mechanical vibrators shall not be used.

The main grouting and the grouting of bolt sleeves and pockets should normally be carried out at the same time. If separate operations are advisable bolt sleeves and pockets shall be grouted up to approximately 50mm below the level of the concrete foundation before the main grouting.

2.41 Precast Concrete

Unless otherwise specified or described all precast concrete work shall be of Class 30/20.

Moulds for precast units shall be so constructed as to provide a Class F3 finish to the units unless otherwise specified.

Each mould for concrete work which is specified or approved by the Engineer to be precast shall have a different embossed or recessed identification mark in a position to the approval of the Engineer. Each precast unit shall be indelibly marked with the date of casting and after the mould is removed shall not be disturbed for 28 days.

Each precast unit shall, where required, be provided with lifting eyes and holes located to avoid excess stress during handling to the satisfaction of the Engineer. Units requiring removal at a later date for inspection/maintenance shall be provided with permanent lifting points where indicated on the Drawings. These shall be proprietary fixings allowing easy removal of the units and shall have suitable protection against corrosion. They shall not protrude above the finished surface of the concrete.

Temporary lifting points shall be removed or covered up and any holes or recesses shall be filled after installation of the precast units.

Precast units must be of a sufficient age and handled with sufficient care to avoid permanent damage. The Contractor shall take steps to ensure the even seating of all pre-cast members on their bearings to the satisfaction of the Engineer.

2.42 Measurement and Payment**2.42.1 Concrete****2.42.1.1 Measurement**

Measurement, for payment, of concrete required to be placed directly upon or against surfaces of excavation will be made to the lines for which payment for excavation is made.

Measurement, for payment, of all other concrete will be neat lines of the structures as shown on the Drawings unless otherwise prescribed in this Specification.

In measuring concrete for payment, deductions will be made for the volume of all ducts, embedded pipes, surface conduits and drains, recesses for rails and gate guides in first stage concrete, embedded metalwork and other blockouts having a cross-sectional area larger than 0.10 m² as measured at right angles to their longitudinal axis. Deductions will also be made for all openings, recesses and blockouts with cross-sectional areas less than 0.10 m² but which have an individual volume larger than 0.5 m³.

Measurement, for payment, for concrete required for treatment of defects outside the excavation pay lines other than in excavation for underground works will be made for the actual volume of concrete directed to be placed in these locations.

Measurement, for payment, of backfill / dental concrete will be made of the actual volume of concrete placed as directed by the Engineer.

Measurement of precast concrete shall be made as per dimension shown on drawings.

2.42.1.2 Payment

Payment for concrete in the various parts of the Works will be made at the applicable rates per cubic meter tendered in the priced Bill of Quantities. These rates shall include the cost of all labour, constructional plant, formwork and materials including cement required in the construction, except that payment for providing and placing or installing reinforcing bars.

Payment will not be made for concrete required to be placed outside specified or approved excavation pay lines due to over-breakage, excess excavation or wasted concrete, or for any other reason.

Direct payment will not be made for cement used in concrete, mortar, shotcrete, dry-pack or grout for filling the cavities.

The cost of producing or providing aggregates required under this Specification shall be included in the rates tendered in the priced Bill of Quantities for the various grades of concrete construction in which the aggregate is used.

The Contractor will not be entitled to any additional payment for materials wasted from deposits, including crusher fines, excess material of any of the sizes into which the aggregates are required to be separated by the Contractor and materials which have been discarded by reason of being above the maximum sizes specified for use.

The cost of contraction joints shall be included in the rate tendered in the priced Bill of Quantities for the concrete in which the joints are required.

The cost of expansion joints shall be included in the rate tendered in the priced Bill of Quantities for the concrete in which the joints are required.

The cost of all labour and materials for forms and for any necessary treatment or coating of forms shall be included in the rates tendered in the priced Bill of Quantities for concrete for which the forms are used.

All materials, labour and construction plant required for the repair of concrete shall be provided at the expense of the Contractor.

No payment will be made for the backfill / dental concrete to fill the over excavation due to negligence and fault of Contractor.

- A. The cost of placing concrete in blockouts, and dry pack and grout under base plates of equipment and machinery supplied and installed by the Contractor shall be deemed to be included in the rates tendered in the priced Bill of Quantities for items of work for which the concrete and grout is required.

No separate payment will be made for injection of cement grout or epoxy grout for filling the gap or cavity within hardened concrete.

2.42.1.3 Unit of Measure

Unit of measure: Cubic Meter

2.42.2 Reinforcing Bars and Fabric

2.42.2.1 Measurement

Measurement, for payment, of providing and placing reinforcing bars and fabric will be made only of the calculated mass of the bars placed in the concrete in accordance with the Drawings or as directed. The calculated mass for reinforcing bars and fabric shall be determined as follows:

- (a) Reinforcing bars – The calculated mass shall be based on the mass per meter calculated from nominal diameter of the reinforcing bar and the mass density of steel of 7,850 kg per cubic meter.

- (b) Reinforcing Fabric – The calculated mass shall be based on the mass per unit area of the fabric based on the theoretical area of the bars and spacing and the mass density of steel of 7,880 kg per cubic meter.
- (c) All joints or splices shown on the Drawings or directed will be measured for payment as laps. Mechanical coupling approved by the Engineer, will be measured for payment in terms of length of equivalent lap joint. Additional joints or splices will not be measured for payment.

2.42.2.2 Payment

Payment for providing and placing reinforcing bars fabric will be made at the rate per tonne tendered therefor in the priced Bill of Quantities.

These rates shall include the cost of preparing reinforcement detail drawings, scheduling reinforcement and of furnishing and attaching wire ties and metal, concrete or other supports, of cutting, bending, cleaning, securing and maintaining in position all reinforcing bars. Payment will not be made for joints or splices, nor for reinforcement used in miscellaneous precast concrete units.

2.42.2.3 Unit of Measure

Unit of measure: Tonne

3. BRICKWORK

3.1.1 SCOPE

All brick masonry required to be constructed under these specifications for masonry buildings, structures, piers, abutments, and perforated as directed by the Engineer-in Charge, shall consist of the materials herein specified and cement sand mortar shall be proportioned, mixed, and bricks placed in accordance with the requirements stated herein. The requirements set forth herein shall apply to all brickwork, except when such requirements are specifically modified by the Engineer-in-Charge for any particular item of work.

3.1.2 APPROVAL OF SUPPLY SOURCE

All products supplied under this section must be obtained from an approved source with respect to strength and quality. The contractor will not be permitted to change the source of supply without the permission of the Engineer-in-Charge.

3.2.1 CLAY MASONRY UNITS (BRICKS)

The clay bricks shall be manufactured from good firm loam with a clay content ranging from 10 to 20 percent as per BS 6669, which will give plasticity index of 7. The earth shall be free from objectionable quantities of lime, gravel, coarse sand and roots or other organic matter. Salts and calcium silicates in the earth shall not exceed 0.5% and 2.0% respectively as given in BS 187. The common burnt clay bricks shall be hand moulded or machine moulded. They shall be free from nodules of free lime, visible cracks, flaws warp age and organic matter, have a frog 100 mm in length 40 mm in width and 10 mm to 20 mm deep on one of its flat sides as per BS 4729. Bricks made by extrusion process and brick tiles may not be provided with frogs. Each brick shall be marked (in the frog where provided) with the manufacturer's identification mark or initials.

3.2.2 DIMENSIONS

Nominal size of bricks/tiles shall be as follows as per BS 4729: Bricks 9 inches x 4-1/2 inches x 3 inches (225x113x75mm) Tiles 12 x 6 x 2 inches (300x150x50mm) 12 x 6 x 1-1/4 inches 9 x 4-1/2 x 2 inches The bricks shall have smooth rectangular faces with sharp corners and shall be uniform in colour and emit clear ringing sound when struck. Bricks required for construction works usually measure 225x113x75 mm as nominal size. However, Bricks/Tiles used for special works shall measure according to the special needs. 11.4 CLASSIFICATIONS Bricks as they come from the kiln are stored and stacked in stacks of one or two thousands separately, accordingly as they are First Class, Second Class, Third Class (under burnt or pilla) Fourth Class (over-burnt or Jhama) and Fifth Class (Sundried) Bricks.

3.2.3 FIRST CLASS BRICKS

The size of bricks shall be as specified. They shall be well burnt without being vitrified. They shall be of uniform colour, regular in shape and size, with sharp and square corners and parallel faces. They must be homogeneous in texture and emit a clear ringing sound when struck. They shall be free from flaws and cracks. They shall not absorb more than 1/6th of their weight of water after being soaked for one hour at a temperature of 24 to 26°C, and shall show no signs of efflorescence on subsequent drying. The average compressive strength of five representative bricks shall not be less than 1800-

2000 pounds per square inch. When tested in accordance with ASTM Designation: C-67. If 10 bricks per thousand are defective or if the average weight of nominal 9 inches' x 4-1/2 inches' x 3 inches (with tolerance of 0.11 inches only) brick is less than 5.5 lbs (2.5 Kg) or brick are out of dimension, the whole lot shall be rejected and the contractor shall remove the rejected lots from the site free of cost. In addition to above, for bricks required in connection with lining of Canals, salt content in the earth shall not be more than 0.3%. perforated bricks shall be manufactured as per specified design and perforations.

3.2.4 SECOND CLASS BRICKS

Second class bricks shall be as well burnt as first class, or slightly over-burnt but not vitrified in any part and must give a clear ringing sound when struck. In this class of bricks slight irregularities in size, shape, or colour will be accepted but not such as to give irregular or uneven courses when used. Second class bricks may have slight chips or flaws. They shall not absorb more than 1/4th their weight of water after one hour's immersion in water of 24 to 26oC. Their compressive strength shall not be less than 1500 pounds per square inch. The average weight of bricks shall not be less than 5.5 lbs. (2.5 kgs).

3.2.5 THIRD CLASS BRICKS OR UNDER-BURNT OR PILLA BRICKS

These bricks are not as fully burnt as first or second class bricks. Any defects in uniformity or shape must not be such as to cause difficulty in obtaining uniform courses with their use. Their compressive strength shall not be less than 1000 lbs. per square inch. The use of third class bricks is prohibited except as substitutes for sundried bricks. These bricks shall not be allowed for face work. Joints in third class bricks shall be 1/2 inch, but shall in no case exceed 5/8 inch. The height of four courses laid according to the above specifications with 4 horizontal joints shall not exceed 2 inches the height of 4 bricks piled dry, one upon another.

3.2.6 FOURTH CLASS JHAMA BRICKS

Jhama bricks are bricks so over-burnt as to get vitrified or distorted and are useless for exact work. Their compressive strength shall not be less than 725 lbs. per square inch. They may be broken up for ballast provided the vitrified mass has not become porous or spongy in the process of being over-burnt.

3.2.7 FIFTH CLASS OR SUNDRIED BRICKS

Sundried bricks shall be un-burnt bricks. Any defects in uniformity or shape must not be such as to cause difficulty in obtaining uniform courses with their use. Their compressive strength shall not be less than 500 lbs. per square inch.

3.2.8 STACKING:

The bricks shall be sorted and arranged in stacks of one or two thousands as specified. Each stack shall be 10 courses high and two bricks thick so that at least one ends of every brick are visible. At least two feet space between the stacks shall be left for the purpose of inspection. Each class of bricks shall be stacked separately. Samples of bricks shall be subjected to the following tests: (a) Dimensional tolerance. (b) Water absorption. (c) Efflorescence. (d) Compressive strength.

3.2.9 SAMPLING

For carrying out compressive strength, water absorption, efflorescence and dimensional tests, the samples of bricks shall be taken by one of the methods given below:-

Sampling Bricks or Tiles from a Motion:

Whenever practicable samples shall be taken whilst the bricks or tiles are being moved; for example, during loading or unloading, in this case the bricks or tiles shall be taken at random from each of a number of convenient portions of the consignment or batch. The portion chosen should be small enough in relation to the whole to provide the minimum number of samples specified below.

Sampling Bricks or Tiles from a Stack:

Samples shall be taken each at random from a stack of bricks or tiles. The number of bricks required for the tests shall be taken from across the top of the stack, the sides accessible and from the interior of the stack by opening the trenches from the top.

Whichever method is employed, a sample of 50 bricks/tiles shall be taken at random from every consignment of 50,000 bricks/tiles or part thereof. The samples thus taken shall be stored in a dry place not in contact with the ground until the tests are made. The bricks for tests shall be taken at random from the sample.

3.2.10 TESTING OF SAMPLES

Visual & Dimensional Characteristics The Visual & Dimensional Characteristics of bricks/tiles as specified under 3.4.1, 3.4.2 & 3.4.6 shall be checked on a sample of 20 first class & 2nd class bricks.

3.2.11 COMPRESSIVE STRENGTH

The average compressive strength of five representative bricks, when tested according to ASTM Designation C-67 shall have a minimum average compressive strength for various classes as given in Sub-Section 3.5. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%.

Designation Average compressive strength (lbs/Sq.inch) First Class 2000 Second Class 1500 Third Class 1000 Fourth Class 725

3.2.12 WATER ABSORPTION

This test is significant as it gives an index of the durability of brick. The average water absorption of first class & second class bricks for a sample of five bricks when tested shall be not more than as specified in Clause 3.4.1 and 3.4.2.

3.2.13 EFFLORESCENCE

The bricks checked for water absorption as per Clause 3.5.4 shall show no signs of efflorescence in drying.

3.2.14 CRITERIA OF ACCEPTANCE

If more than 10% bricks in the stacks do not conform to any of the specification requirements, then the whole consignment shall be rejected.

3.2.15 CLASSIFICATION

The brick work shall be classified according to the class designation of bricks used. The specifications stated hereof are for First class brick masonry in cement sand mortar except specified otherwise.

3.2.16 MORTAR

The cement sand mortar for the brick work shall be as specified.

Cement Mortar Composition

Cement mortar shall consist of one part Portland cement to specified number of parts of dry loose sand (Fine aggregate) by volume and sufficient water to produce proper consistency for intended use. Waterproofing agent not exceeding 25% by volume of dry cement shall be added when specially required or directed by the Engineer-in-Charge.

1. Materials

- a) Portland Cement Portland Land cement shall conform to ASTM C 150-94 Type I or B.S.S.12.
- b) Sand Sand shall be such that it passes through a No.16 sieve and not more than 30 percent, passes through a sieve of 100x100 meshes in the square inch. The sand used or supplied shall be clean sand, gritty to the touch and free from any admixture of clay, loam, salts, organic matter or other impurities. The sand shall be of such cleanness that when a handful of it is shaken in a glass with clean water and allowed to stand for one hour the precipitation of mud (or flour in the case of screenings) on the sand shall not exceed 10%. If more than this precipitate is found, the sand shall be washed. The source of the sand is subject to the approval of the Engineer-in-Charge from the designated sources.
- c) Water Water shall conform to specifications for water for mud mortar clause 3.7.2.

2. Mix

Unless otherwise specified or directed by the Engineer-in-Charge, the ingredients for cement mortar shall be proportioned by volume.

3. Preparation

- a) Methods and equipment used for mixing mortar ingredients – including their mixing in dry state – shall be such as will accurately determine and control the amount of each separate ingredient entering into the mortar and shall be subject to the approval of the Engineer-in Charge. Normally cement and sand is thoroughly mixed in a dry state on a pucca platform or in troughs as directed by the Engineer-in-Charge. It shall be gauged with a quantity of water sufficient to make the mortar workable. Water shall be added with a fine rose. Only such quantity of mortar shall be prepared as can be used before the initial setting time.
- b) If a mixer is used, it shall be of the approved design. The mixing time after all the ingredients are in the mixer, except for the full amount of water, shall be not less than two minutes. Water shall be added at a uniform rate during the mixing time.
- c) Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within thirty (30) minutes after addition of the water to the mix shall be wasted. Re-tempering of mortar will not be allowed. Mixing troughs and pans shall be thoroughly cleaned and washed at the end of each day's work. When colour for face work is specified to be mixed in it shall be of approved quality and

brand and shall be added in such quantity to obtain the required shade, water proofing material shall be added only when specifically directed.

4. Measurements

The measurement of mortar, if required, shall be done by volume. The unit of measurement shall be cubic meter..

5. Rate

The unit rate shall include the cost of Portland cement, sand and water and the preparation of mortar as per above specifications at the site of work to be defined in the condition of contracts.

3.3.1 SOAKING OF BRICKS

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. The soaking of bricks would be for 2 to 3 hrs. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. The bricks required for masonry work using mud mortar shall not be soaked. When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of application they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

Note 1: The period of soaking may be easily found at site by a field test in which the bricks are soaked in water for different periods and then broken to find the extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in construction work.

Note 2: If the bricks are soaked for the required time in water that is frequently changed the soluble salt in the bricks will be leached out, and subsequently efflorescence will be reduced.

3.3.2 PLACING BRICK MASONRY

a) The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the brick nor delay the use of mixed mortar.

b) All brickwork shall be placed only after the foundation surface has been prepared satisfactory in accordance with these Specifications and the Engineer's instructions.

c) All bricks to be used in brickwork with mortar joints except with mud mortar joints shall be moistened with water for three to four hours before they are used, by a method which will ensure that each brick is thoroughly and uniformly wetted. All bricks shall be free from water adhering to their surface when they are placed in the brickwork. This bricks shall be laid strictly in accordance with the Drawing or as directed by the Engineer.

d) Brick work shall not be carried out during rains sufficiently heavy or prolonged to wash the mortar from the bricks. Mortar already spread, which becomes diluted by rain, shall be removed and replaced before continuing with the work. Fresh laid brickwork shall be covered with polyethylene sheets to avoid dilution and removal of mortar. Workman shall not be allowed to walk on the brickwork before

it is fully set. All walls or other brickwork shall be securely braced and protected against damage by wind and storms during the construction period.

e) Bricks shall be skillfully laid from up and each bricks shall be set with both bed and vertical joints filled with mortar and the bricks shall be bedded in by firmly tapping with the handle of the trowel. Bricks course shall be carried up as neatly as possible in a uniform manner and carefully plumbed on both sides. No portion of the brickwork shall be raised more than one meter above another at the same time. Straight edges supplied to bricks layers shall have course marked on them with saw cut or measuring rods shall be provided to check the height of course and their horizontality. All unavoidable changes in slopes shall be raked back at a slope of two horizontal to one vertical. All anchors and similar work required to be embedded in brick masonry shall be installed as the construction progress. The exposed face of all brick masonry shall have the smoothest finish and be kept clean and free from streak of mortar. Wherever such streaks are formed they shall be parallel whereas vertical joints in alternate course shall be directly over one another. The thickness of the vertical joints shall be approximately 6 millimetres and the thickness of the horizontal joins shall be 10 millimetres. Except where otherwise specified excess mortar at the outer edges shall be removed and joints drawn straight with the edge of a trowel and straight edge. At the completion of the work all holes or defective mortar joints shall be cut out and repointed.

3.3.3 Laying

a) General

The brick laying shall be carried out complete with all embedment and installations for completion of the construction as shown on drawings and directed by the Engineer-in Charge. Bricks shall be laid in English Bond unless otherwise specified. For brick work in half brick wall, bricks shall be laid in stretcher bond. Half or cut bricks shall not be used except as closer where necessary to complete the bond. Closers in such cases, shall be cut to the required size and used near the ends of the wall. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment.

Note:

Header bond shall also be used in foundation footings unless thickness of walls (width of footing) makes the use of headers impracticable. Where thickness of footing is uniform for a number of courses, the top course of footing shall be headers. All loose materials, dirt and set lumps of mortar which may be lying over the surface on which brick work is to be freshly started, shall be removed with a wire brush and surface wetted. Bricks shall be laid on a full bed of mortar, when laying, each brick shall be properly bedded and set in position by gently pressing with the handle of a trowel. It's inside face shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow spaces are left inside the joints.

b) Bedding of Bricks

While bedding bricks, both the bed and side joints must be thoroughly flushed or filled up with mortar.

c) Levelling

While bedding bricks, great care should be taken to keep all courses perfectly level. To do this, the footing and the starting course should be carefully levelled, using a spirit level with a staff at least 10 feet long

3.3.4 Construction of Walls

a) The walls shall be taken up truly in plumb or true to the required batter where specified. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in the alternate course shall come directly one over the other. Quoin, Jambs and other angles shall be properly plumbed as the work proceeds. Care shall be taken to keep the perpends properly aligned within following maximum permissible tolerances:

- (i) Deviation from vertical within a storey shall not exceed 6 mm per 3 m height.
- (ii) Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5 mm.
- (iii) Deviation from position shown on plan of any brick work shall not exceed 12.5 mm. (iv) Relative displacement between load bearing wall in adjacent storeys intended to be vertical alignments shall not exceed 6 mm.
- (v) A set of tools comprising of wooden straight edge, Masonic spirit levels, square, 1 metre rule line and plumb shall be kept on the site of work for every 3 masons for proper check during the progress of work. All quoins shall be accurately constructed and the height of brick courses shall be kept uniform. This will be checked using graduated wooden straight edge or storey rod indicating height of each course including thickness of joints. The position of damp proof course, window sills, bottom of lintels, top of the wall etc. along the height of the wall shall be marked on the graduated straight edge or storey rod. Acute and obtuse quoins shall be bonded, where practicable in the same way as square quoins. Obtuse quoins shall be formed with squint showing three quarters brick on one face and quarter brick on the other. The thickness of brick walls is regulated by the following rules which only apply to walls which are not more than 45 feet long between supports or cross walls and buildings three storey high. Local authority by-laws may be referred for more detail information. Walls built for various types of brick work detailed in table below, should not go beyond the maximum permissible height shown for various thicknesses, subject to the further limitations;

- i. The bricks are not less than 9 inches long.
- ii. The thickness of external and party walls (i.e. walls separating adjoining building) is not less than 1/16th of the height of the storey in case of ordinary buildings and 1/14th in case of warehouses. The thickness of walls below is increased to a like extent, though any such additional thickness is confined to piers, properly distributed, of which collective width amount to 1/4th of the length of wall.
- iii. Thirteen inches and half is the minimum thickness for external party walls of any story more than 10 feet high.
- iv. The thickness of cross walls is 2/3 the thickness of the external party walls but never less than 9 inches except in case of bricks in cement suitably reinforced with steel). No wall should be considered a cross wall unless it is carried up to the floor of the top most story and unless in each story the combined area of openings and recesses is less than 50% of the wall area. Properly bonded cross walls may be considered return walls for determining the length of external or party walls

Raking

The brick work shall be built in uniform layers. No part of the wall during its construction shall rise more than one metre above the general construction level. Parts of wall left at different levels shall be raked back at an angle of 45 degrees or less with the horizontal by setting back 2-1/2 inches at each course, with a maximum of twelve courses, to reduce the possibility and the unsightliness of defects caused by any settlement that may take place in the most recently built portion of the wall. Toothing shall not be permitted as an alternative to racking back. For half brick partition to be keyed into main walls, indents shall be left in the main walls.

c) Other Factors All pipe fittings and specials, spouts, hold fasts and other fixtures which are required to be built into the walls shall be embedded, as specified, in their correct position as the work proceeds unless otherwise directed by the Engineer-in-Charge. Top courses of all plinths, parapets, steps and top of walls below floor and roof slabs shall be laid with brick on edge, unless specified otherwise. Brick on edge laid in the top courses, at corner of walls shall be properly radiated and keyed into position to form cut (marrow) corners as specified. Where bricks cannot be cut to the required shape to form cut (marrow) corners, cement concrete 1:2:4 (1 cement :2 coarse sand: 4 graded stone aggregate 20 mm nominal size) equal to thickness of course shall be provided in lieu of cut bricks. Bricks shall be laid with frog (where provided) up. However, when top course is exposed, bricks shall be laid with frog down. For the bricks to be laid with frog down, the frog shall be filled with mortar before placing the brick in position. In case of walls one brick thick and under, one face shall be kept even and in proper plane, while the other face may be slightly rough. In case of walls more than one brick thick, both the faces shall be kept even and in proper plane. To facilitate taking service lines later without excessive cutting of completed work, sleeves shall be provided, where specified, while raising the brick work. Such sleeves in external walls shall be sloped down outward so as to avoid passage of water inside. Top of the brickwork in coping and sills in external walls shall be slightly tilted. Where brick coping and sills are projecting beyond the face of the wall, drip course/throating shall be provided where indicated. Care shall be taken during construction that edges of jambs, sills and projections are not damaged in case of rain. New built work shall be covered with gunny bags or tarpaulin so as to prevent the mortar from being washed away. Damage, if any, shall be made good to the satisfaction of the Engineer-in-Charge.

d) Stability The stability of brickwork is affected in three general ways: 1. By loading a given area of ground beyond its ultimate resistance, by an irregular concentration of great pressures on a soft sub-soil, by the tendency of the sub-stratum to slid or by eccentric loadings, the walls are thrown out of the upright, crack or disintegrate. 2. By bad bonding, resulting in disintegration. 3. By side thrusts which may be distributed or concentrated, and their tendency is to overturn the walls; they are provided for by designing the walls of a sufficient thickness, or by placing buttresses at regular intervals.

3.3.5 JOINTS

The horizontal joints shall be parallel whereas vertical joints in alternative courses shall be directly over one another. The thickness of the vertical joints shall be approximately 6 millimetres and the thickness of horizontal joints shall be 10 millimetres. Finishing of Joints: The face of brick work may be finished flush or by pointing. In flush finishing either the face joints of the mortar shall be worked

out while still green to give a finished surface flush with the face of the brick work or the joints shall be squarely raked out to a depth of 1 cm while the mortar is still green for subsequently plastering. The faces of brick work shall be cleaned with wire brush so as to remove any splashes of mortar during the course of raising the brick work. In pointing, the joints shall be squarely raked out to a depth of 1.5 cm while the mortar is still green and raked joints shall be brushed to remove dust and loose particles and well wetted, and shall be later refilled with mortar to give ruled finish. Some such finishes are 'flush', 'weathered', ruled, etc.

3.3.6 CURING

The brick work shall be constantly kept moist on all faces for a minimum period of seven days. Brick work done during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

3.3.7 SCAFFOLDING

Scaffolding shall be strong to withstand all dead, live and impact loads which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work and safe working.

3.4 Measurement and Payment

3.4.1 Brick Masonry

3.4.1.1 Measurement

Brick masonry will be measured by volume each type of masonry constructed according to drawings. No deductions will be made for openings less than 400 square centimeters. Control joints, mortar, grout, masonry cleaning and miscellaneous accessories will not be measured separately for payment, such items will be considered incidental to, and include with the concrete blocks masonry.

3.4.1.2 Payment

Concrete block masonry will be paid for at the tendered unit prices.

3.4.1.3 Unit of Measure

Unit of Measure: Cubic meter

3.4.2 Plastering

3.4.2.1 Measurement

The measurement of plastering shall be made in square metres of the surfaces actually plastered to the thickness as shown on drawings or as specified.

3.4.2.2 Payment

The payment for cement mortar plastering of the structure surfaces shall be made at the rate tendered therefor and shall be full compensation for the materials, equipment and labour used for satisfactory completion.

3.4.2.3 Unit of Measure

Unit of Measure: Square meter

4. METALWORK

4.1 Materials

- (1) Structural steelwork shall comply with recognized standards for structural purposes.
- (2) Bolts, washers etc., for use with structural steel shall be black bolts. Fastening including bolts, for use with materials having a galvanized finish shall be sherardised or have an alternative approved protective metal coating.
- (3) Before ordering or fabricating any item of metalwork, the Contractor shall submit to the Engineer for his approval shop drawings showing all details and dimensions required for fabrication, assembly and erection. Fabrication shall only commence after the approval of the Engineer has been obtained.
- (4) Angles, channels, flats and all standard steel section shall be to the sizes given on the Drawings.
- (5) Angles or channels used for framing of openings in concrete structures or for guides shall be provided with steel fixing lugs securely welded to the frame or guide to galvanizing.
- (6) Corrosion protection shall be as detailed on the Drawings or in the Bill of Quantities to the quality and standard specified.

4.2 Ladders, Stairs, Handrails and Open Flooring

- (1) Unless otherwise stated, all steelwork shall be hot dip galvanized.
- (2) Steel runged ladders shall conform to international safety standards and as amplified by the details given in the Bill of Quantities or as shown on the Drawings.
- (3) Safety hoops and stringer extensions shall be included where required for safety unless specifically excluded by details given in the Bill of Quantities or on the Drawings.
- (4) Suitable support stays shall be provided for fixing the ladder to the supporting structure so that there is a minimum 200 mm clearance behind the rungs. These connections shall be of the type, which bolts to the supporting structure.
- (5) The spacing of support stays shall not exceed 2.4 m. in cases where this is not practicable, the stringers shall be suitably strengthened structured.
- (6) Ladders for the wet well of main pumping stations, refer to part II (E/M Works) item 3.17.4 of these Specifications.

- (7) Staircases shall be as detailed on the drawings and be designed to carry a loading of minimum 5 kN/m².
- (8) Staircases shall have continuous handrails approximately 1 m high measured from the tread nosing.
- (9) The upper face of rungs shall be finished with a non-slip surface such as silica sand and all remaining surfaces shall be free of sharp edge protrusions etc.
- (10) Each rung shall be able to support a point load of minimum 5 kN when applied at the center of the rung and close to one end.
- (11) When horizontal supported over a span of 1.0 m with the climbing face uppermost and with a load of 1 kN applied at the center of the span, the ladder shall not deflect more than 15 mm at the point of application of the load and shall show no permanent deflection after removal of the load. Each ladder fixing shall be capable of withstanding shear and pull-out loads of 5kN.
- (12) Handrails and stanchions shall be safe and stable and properly fixed to the concrete.
- (13) Handrails shall be prefabricated of steel pipes of DN 50 or 65 mm nominal bore, cut to lengths and fixed by welding to the stanchions. Hand railing and fixings shall be designed to withstand a horizontal force at handrail level of 740 N/mr.
- (14) Stanchions shall be as the handrails made of 50 or 65 mm nominal bore shank and be 1000 mm high. They shall be set in sockets cast in the concrete and grouted in non shrink grout. Spacing shall be a maximum of 1500 mm. Side plan type of fixing will only be used where shown on the Drawings or approved by the Engineer.
- (15) Open mesh (Grid Cover) or chequer plate flooring shall be of mild steel. The thickness of plate or construction of open mesh shall be of adequate strength to bear the load of not less than 5 kN/m².
- (16) In addition to the requirements of strength a minimum overall chequer plate thickness of 7 mm and an open mesh minimum member thickness of 3 mm shall be allowed.
- (17) Where a welded construction is used to open mesh flooring the welding shall be continuous, heavy and on both edges of a joint.
- (18) Metal flooring shall in all cases be supported by a properly formed and secured steel kerbing running continuously throughout the length supported. The flooring shall be provided with proper and adequate lifting handholds and where used on suspended supports adequate clips shall be used to prevent any movement of the flooring.

- (19) Mild steel plating, open mesh and kerbing shall be heavily dipped galvanized after cutting, manufacturer and complete fabrication.
- (20) Where metal flooring is placed adjacent to a clear opening it shall include a 100 mm high kicking plate along the full length of the opening. Rates for flooring shall include for kicking plate as described.
- (21) Chequer plate covers over cable / pipes passage in transformer / generator rooms shall be non-slip pattern type and shall be set flush in mild steel frames provided with lugs for building in.
- (22) Handrails, ladder for the wet chamber in main pumping station all to be supplied of stainless steel in accordance. This applies to nuts, bolts, washers, flanges, etc.
- (23) The joints for stainless steel handrailing and ladder should be welded using the proper welding material and method with subsequent proper protection.
- (24) The work is to be carried out as detailed on the Drawings and as specified. All working Drawings should have the approval of the Engineer before fabrication.

4.3 Doors and Windows

4.3.1 Materials

- (1) Steel doors shall be of the hollow metal type constructed in standard profiles and sheet steel.
- (2) Aluminum doors shall be of anodized hollow metal sections constructed in Standard Profiles and sheet aluminum. They shall be thoroughly braced internally, prepared to receive hardware and accurately finished so that the surfaces are true and smooth. Edges angles and covers shall be square, clean sharp. Doors shall be complete with hinges stoppers and locks.
- (3) The doors shall be provided with buffer strips fixed all around the frame.
- (4) Wooden doors shall be of solid core construction with a subsurface of plywood. The leaves shall be fitted with hardwood lipping 1.5 cm thick all around.
- (5) For toilets and showers the leaves finish is decorative laminated plastic sheet 1.5 mm thick. Architrave's on both sides should be 1 x 6 cm fixed to the door frame.
- (6) Windows and frames shall be manufactured of anodized aluminum, to the dimensions given on the Drawings. They should generally be supplied with one horizontally sliding sash complete with sash-bolt unless shown otherwise. Windows installed in offices 2 m or more above the ground shall be provided with bottom hinged sashes with an operating lever to be fixed 1.5 m above floor level including connection to the window. All windows shall be designed to withstand wind pressures and to be dust proof.
- (7) Openings in windows shall be provided with an aluminum fly-screen mesh. In offices the glass shall normally be 5 mm thick clear sheet glass, and in workshop and similar buildings it shall normally 7 mm thick wire reinforced glass.

4.3.2 Installation

- (1) Doors and windows shall be installed plumb and true to line and shall operate smoothly.
- (2) Doors and windows shall be such that glazing or re-glazing on site is possible without the need to remove the outer frame from the structure of the building.
- (3) The Contractor shall submit details of manufacture including sections of all members and no orders shall be placed until such details have been approved by the Engineer.

4.4 Protection

4.4.1 General

- (1) The work detailed in this section refers only to protection applied at the manufacture's works prior to delivery. The protection required subsequently is covered in Section "Paint-Work".
- (2) All paints shall be obtained from one approved manufacturer, and applied strictly in accordance with the manufacturer's instructions. The source of supply shall not be altered without the Engineer's approval. The colour of the paints used shall be of different shades.
- (3) After welding and fabrication, all weld areas shall be thoroughly cleaned and touched up as specified with the appropriate priming system.

4.4.2 Types of Protection

- Type C (Zinc rich epoxy primer)
- Type D (Metallic lead primer applied by brush to a minimum thickness not less than 75 um):
- Type E (Hand or tool cleaning to remove rust, grease etc., for all steel work which is to encased in concrete/):

4.5 Measurement and Payment

4.5.1 Metalwork Fabrication and installation

4.5.1.1 Measurement

Metalwork fabrication and machine work for which payment is not otherwise specifically provided in these specifications, will be measured for payment based upon computed weights per fabricated piece, assembly or cast piece for the various metals as classified on the approved detail drawings except as indicated below. Computed weights shall be indicated on the detail drawings submitted for approval.

Approval of the detail drawings will constitute acceptance of the computed weights shown thereon. When measurement of complicated shapes can be determined more readily by scale weights per fabricated piece, cast piece or assembly the use of certified scale weights will be approved as the basis for measurement.

Computed Weights

Weights for payment shall be the net calculated weights based on the dimensions indicated on the detail drawings. The weight of rolled shapes and plates shall be computed on the basis of their nominal weights and dimensions. In calculating the net weights all copes, cuts and open holes except rivet and bolt holes shall be deducted. No additional weight shall be calculated for overweight allowance, protective coatings, allowance for milling, grip length of rivets and bolts and butt and groove welds. The weight of castings including fillets shall be computed on the basis of the dimensions shown on the detail drawings with deductions for all openings and cuts in the finished casting. Computed weights for fillet welds, rivets, bolts and cut washers shall be included in accordance with the following:

ALLOWANCES FOR WEIGHT OF EQUAL-LEG FILLET WELDS

Leg of weld in Millimeters	Kilograms per meter Length of weld
3	0.045
5	0.089
6	0.160
8	0.250
10	0.360
11	0.490
13	0.630
16	0.980
19	1.400
22	1.900
25	2.500

Note: For unequal-leg fillet welds the weight corresponding to the smaller leg in the above listing shall be multiplied by the ratio of the longer leg to the smaller leg.

ALLOWANCES FOR WEIGHT OF RIVET HEADS

Diameter in Millimeters	Kilograms per 100 heads
13	1.8
16	3.2
19	5.4
22	8.2

25	12.0
29	16.0
32	22.0
35	27.0
38	37.0

ALLOWANCES FOR WEIGHT OF BOLTS - REGULAR SIZE

Diameter in Millimeters	Kilograms per 100 units
13	6.12
16	12.20
19	20.00
22	31.30
25	46.70
29	68.50
32	92.10

ALLOWANCES FOR WEIGHT OF BOLTS - HEAVY SIZE

Diameter in Millimeters	Kilograms in 100 units
13	9.1
16	16.3
19	27.7
22	41.7
25	61.2
29	86.2
32	113.0
38	195.0
44	311.0
50	454.0
57	635.0
64	855.0
70	1100.0
75	1460.0

Note: Allowances for bolts are based on weight data given in AISC manual. Allowances consist of weight of square head, bolt shank (in and projecting beyond nut) and hexagonal nut and shall apply to all type bolts without modification. Projections beyond nuts are assumed equal to 1/2 the bolt diameter up to M50 size bolts and 25 mm for bolt sizes M50 and above. Where the number and size of another type of bolt would result in a significant difference in a pay item the allowances given above should be supplemented to include the additional type of bolt.

ALLOWANCES FOR WEIGHT OF CUT WASHERS

Bolt Diameter in Millimeters	Kilograms of 100 units
13	2.02
16	4.04
19	5.94
22	7.21
25	9.71
29	11.70
32	15.20
35	20.10
38	22.00
44	28.80
50	35.90
57	48.50
64	57.60
70	68.90
75	84.40

Note: Each unit comprise cut washer and bolt shank in depth of washer.

The following weights, per cubic millimeter, will be used in computing weights of metalwork:

Iron Castings	7.20 mg
Steel (All Compositions)	7.83 mg
Copper, Bronze, Brass; Nickel-Copper Alloy	8.61 mg
Lead	11.30 mg
Aluminum	2.77 mg
All Other Metals	7.83 mg

Scale Weights

Shop scale weight measurements shall be made in the presence of the Engineer unless otherwise specifically authorized. The weight of erection bolts, nuts and washers boxes, crates and other containers used for packing and the materials used for supporting members during transportation shall not be included in the scale weights. It shall be the responsibility of the Contractor to prepare the shipping lists required in Clause 11-1.2 - Submittals in a format to allow the correct allocation of the scale weights of individual metal parts and members to the applicable payment classifications. Failure to comply with this requirement to the satisfaction of the Engineer will necessitate measurement of computed weights. The weight of shop applied permanent protective coatings shall not be deducted from scale weights.

4.5.1.2 Payment

Payment will be made for costs associated with metalwork fabrication and machine work not specifically provided for elsewhere, which includes costs for materials, fabricating work, shop and field painting, galvanizing or other metallic coatings and the installation of metal items shown or required by these specifications unless otherwise specified. No separate payment will be made for bolts, nuts, pins, washers, studs and strap hangers and the cost of such items shall be included in the unit prices of items on which they are used. No separate payment will be made for the inspection of welds.

4.5.1.3 Unit of Measure

Unit of measure: Kilogram.

4.5.2 Metal Spiral Stair, Outlet Pipe and Gate**4.5.2.1 Measurement**

Measurement for payment will be made by weight in kilogram of the acceptably furnished and installed different items of work and shall cover all associated cost for completing the different items of work.

4.5.2.2 Payment

Payment will be made by weight in kilogram as measured above for different items of work at corresponding rate tendered therefor in priced Bill of Quantities and shall cover all associated cost necessary for completing the different items of work.

4.5.2.3 Unit of Measure

Unit of measure: Kilogram

4.5.3 Ladders**4.5.3.1 Measurement**

Measurement for payment will be made on number of Ladders of given lengths installed and will cover all associated cost for the same.

4.5.3.2 Payment

Payment will be made for the number of Ladders of given length installed & at the respective rate tendered in Bill of quantities and will cover all associated cost for the same.

4.5.3.3 Unit of Measure

Unit of measure: Each

4.5.4 Steel Chequered Plates and Covers**4.5.4.1 Measurement**

Measurement for payment will be made on the basis of length of steel chequered plates and covers installed of different sizes as shown in the drawings and shall cover all associated cost for all supports etc necessary for completing the item of work.

4.5.4.2 Payment

Payment will be made for the length of steel chequered plates and covers installed at the rate tendered in Bill of Quantities and shall cover all associated cost for all supports etc necessary for completing the item of work.

4.5.4.3 Unit of Measure

Unit of measure: Linear meter

4.5.5 Hand Rails**4.5.5.1 Measurement**

Measurement for payment will be made as linear metre length of acceptably furnished and installed different types of hand rails as shown in the drawings and shall cover all associated cost for completing the items of work as shown in the drawings.

4.5.5.2 Payment

Payment will be made for the length of different types of hand rails as measured above at the respective rates tendered therefor in the priced Bill of Quantities and shall cover all associated cost for completing the different items of work.

4.5.5.3 Unit of Measure

Unit of measure: Linear Metre

4.5.6 Galvanized Steel Trash Rack**4.5.6.1 Measurement**

Measurement for payment will be made in square meter of acceptably furnished and installed galvanized steel trash rack in panels as specified and shown in the drawings.

4.5.6.2 Payment

Payment will be made of the above mentioned area of the item in square meter at the rate quoted therefor in the priced Bill of Quantities and shall cover all associated costs of works required for the completion of the item of work.

4.5.6.3 Unit of Measure

Unit of Measure: Square Meter

5. PAINTING WORK

5.1 General

Except where otherwise specified, all painting and polishing shall be applied in conformity with CP 231 "Painting" as applicable to the work shown on the drawings and in the Bill of Quantities.

5.2 Material

Materials of painting and polishing shall be high grade products of known manufactures approved by the Engineer and shall be delivered to the site in original unbroken packages bearing the maker's name and brand.

13.3 Workmanship

1. (l) All surfaces shall be clean, dry and free from dust at the time any coating is applied.
 - (ii) Wood work shall be smooth and free from raised grains or other surface imperfections. Knots and piles streaks nails, holes, cracks and similar blemishes, shall be neatly puttied and sanded smooth.
 - (iii) Plastered surfaces shall be allowed to dry for a minimum of 15 days prior to painting and cleaned until free of all loose and foreign materials and excess mortar, using metal scrappers and wire brushes if necessary. Grades and oil spots shall be removed by suitable cleaning compound and then rinsed with clean water to remove all traces of alkali efflorescence (alkali salts). Interior concrete surfaces shall be washed with zinc sulphate solution mixes in proportion of 2 ½ to 3 pints to a gallon of water. Treated surfaces shall be allowed to dry thoroughly before any paint is applied. Plaster patches shall be worked to match the appearance of the adjoining plaster.
 - (iv) Ferrous surfaces that have not been shop painted shall be kept clean and free from corrosion before installation. All rust shall be removed before priming. Abraded or corroded spots on shop-coated surface shall be wire brushed and touched up with the same material as the top coat. Dents, hollow places, open joints and any other irregularities in metal work shall be filled in with approved metal body filler suitable for the purpose and sanded to smooth and hard finish.
2. Plastic Emulsion/Enamel Painting
 - (i) Two coats (except where otherwise provided) of plastic emulsion/enamel paint over a coat of priming shall be applied on the approved prepared

surface faces in accordance with manufacturer's general instructions and/or directions of the Engineer.

- (ii) Each coat of paint shall be evenly worked and allowed to dry before any subsequent coat is applied or any rubbing is done. The primary coat shall be thinner than the subsequent coats to assist penetration and adhesion.
- (iii) Finish coat shall be of the exact shade approved by the Engineer. It shall be very carefully crossed and laid off so that brush marks are not visible. The finished work shall be free from runs and sags, defective coverage and clogging or lines or angles. Edges of paint adjoining other material or other colour shall be full and cleaned out without overlapping.
- (iv) Spray painting shall not be employed for joinery work which must be done by brush to obtain proper penetration into joints and cracks etc.
- (v) When painting is applied by brushes, the brushes shall be in conformity to the applicable requirements of BS 2992. All coats shall be spread as evenly and smooth as possible by crossing and laying off. Brushes shall be reversed at frequent intervals so that they wear down evenly. A free easy stroke shall be cultivated, avoiding short and jerky strokes and stretching the strokes too far.

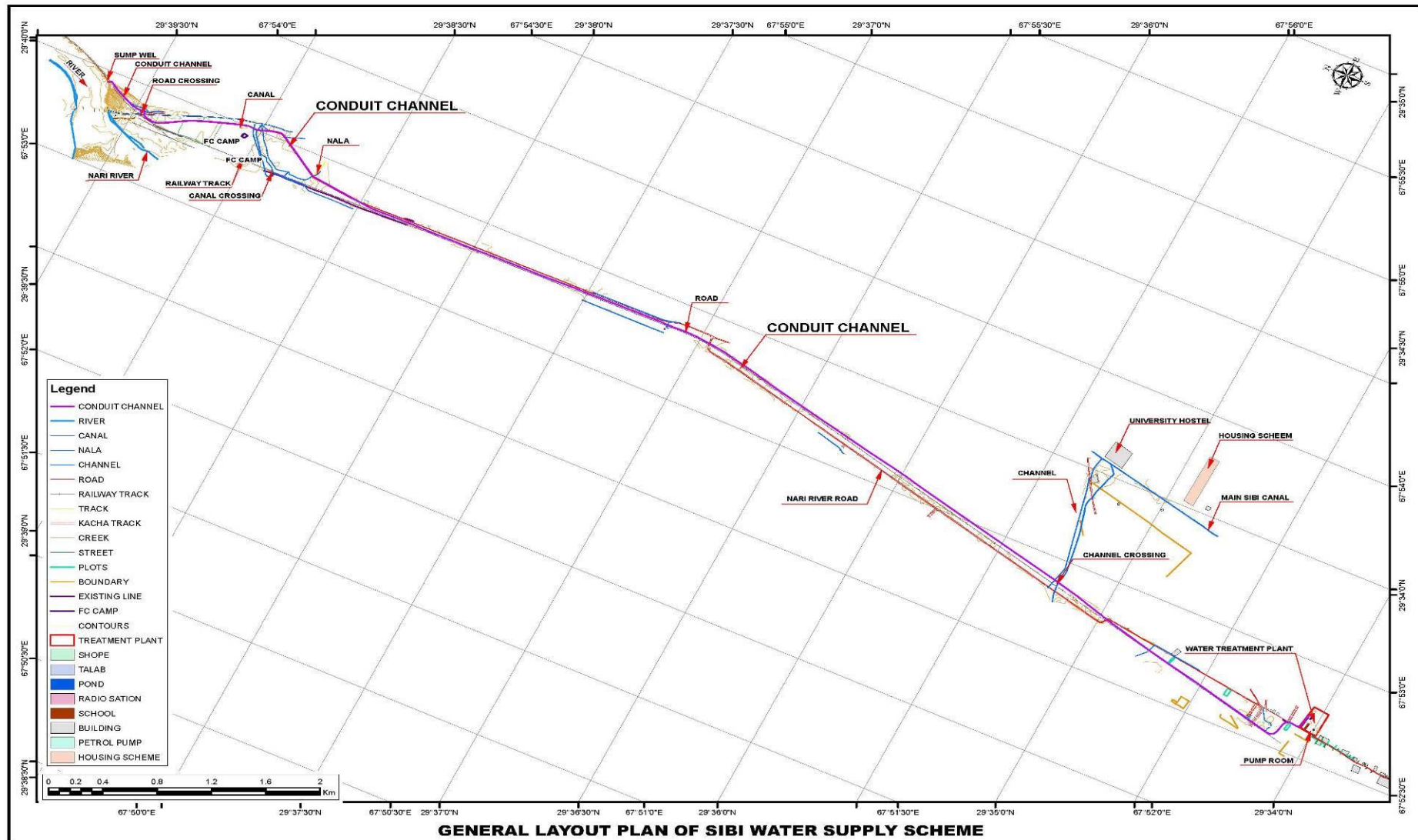
3. Touching up

At the completion of other items of work, all finished work shall be touched up and restored where damaged or defaced and the entire work left free from blemishes, spots etc.

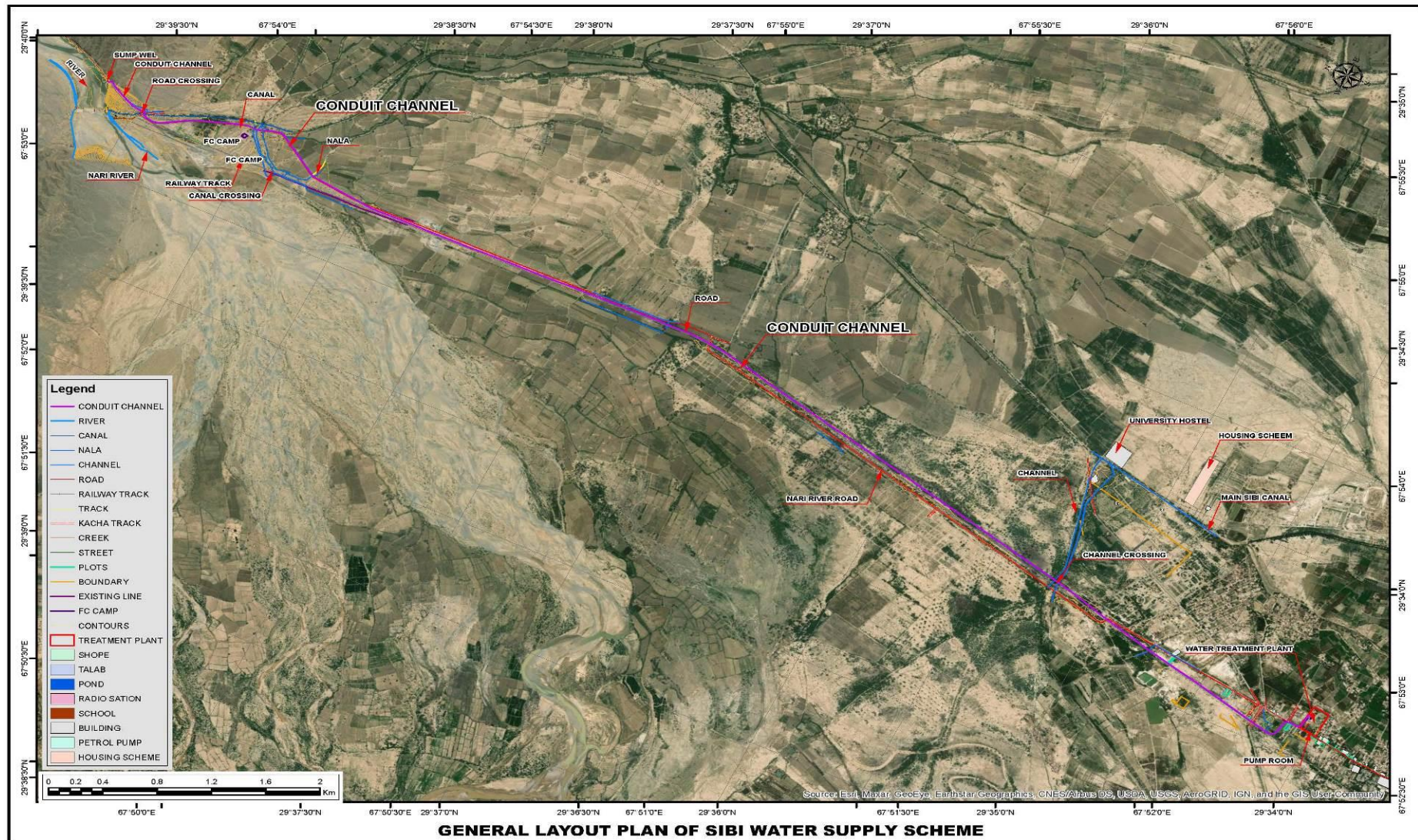
4. Drawings

The Bidding Documents includes *the following* drawings

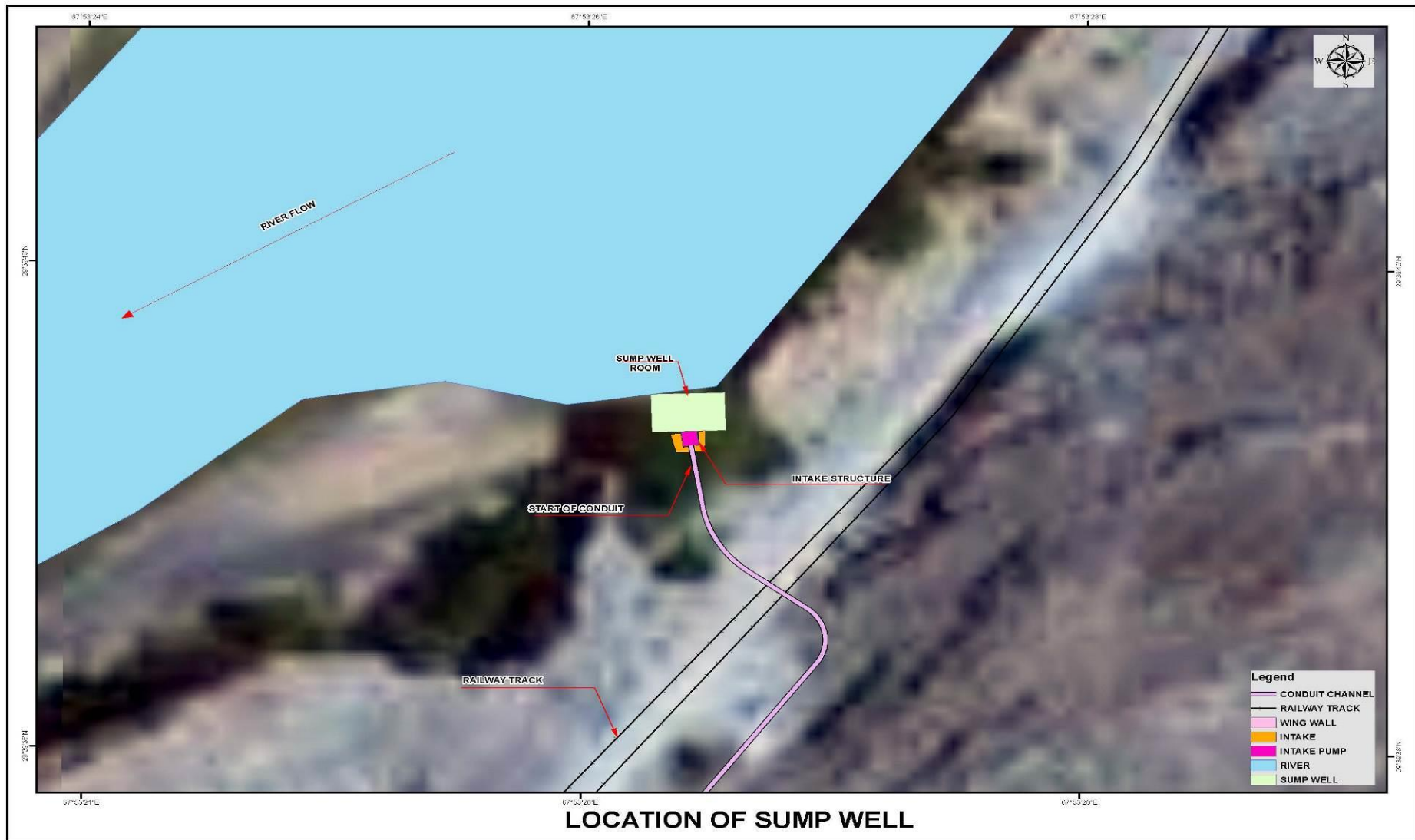
List of Drawings	
Drawing No.	Description and Purpose
Drawing No.1	Location Plan and Conduit Layout – Sibi Water Supply Scheme
Drawing No.2	General Layout Plan Sibi Water Supply Scheme
Drawing No.3	Location Plan of Sump Well
Drawing No.4	Location Plan of Sump Well (Existing Head Regulator)
Drawing No.5	Sibi WSS Treatment Plant Layout
Drawing No.6	Location of Nari Road Tube Wells
Drawing No.7	Location of Talli Tube Wells
Drawing No.8	Google Map showing Layout Sibi Town WSS
Drawing No.9	Schematic showing Existing Boundary Wall and Boundary Wall to be Constructed



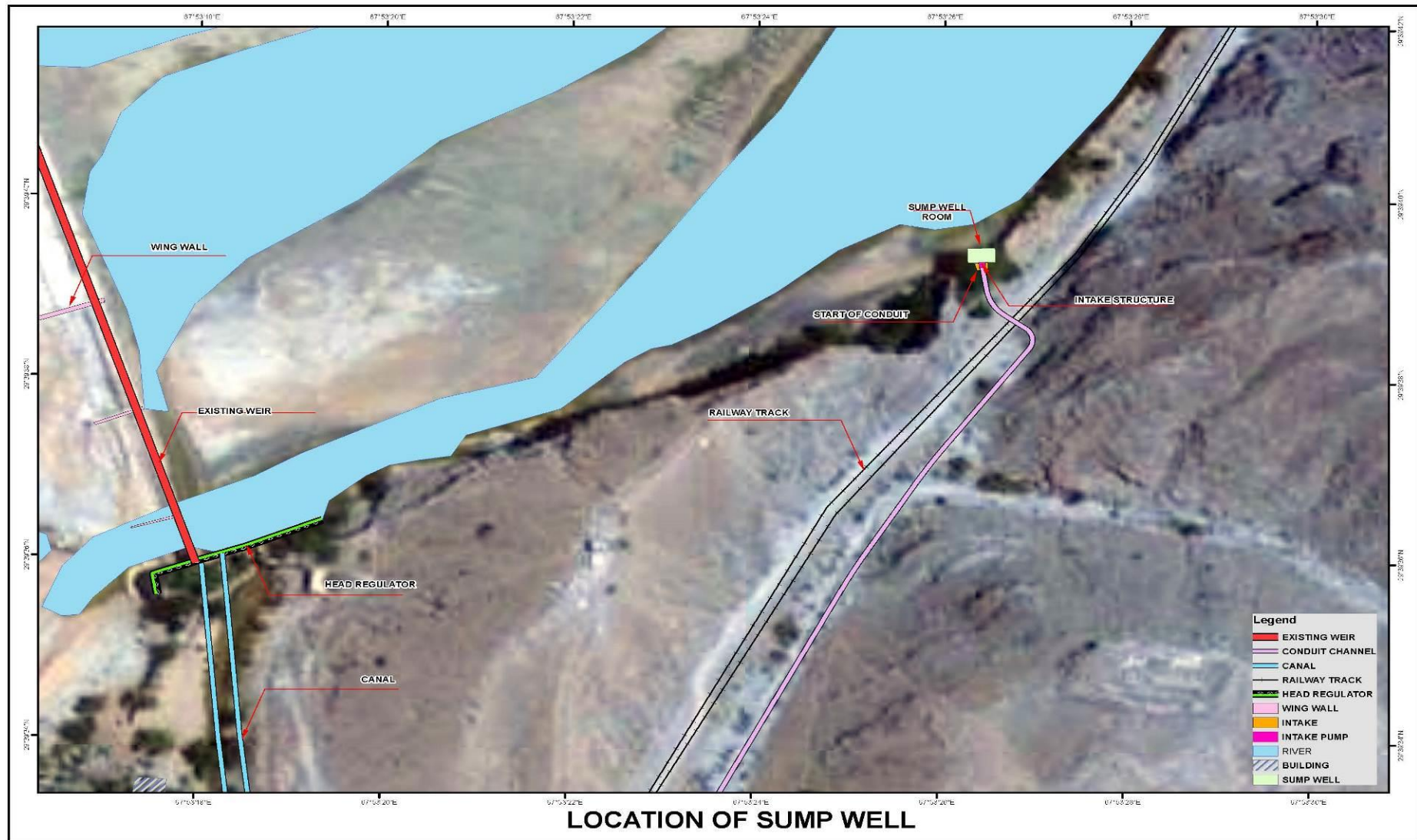
Drawing No. 1 – Location Plan and Conduit Layout Sibi Water Supply Scheme



Drawing No. 2 – General Layout Plan Sibi Water Supply Scheme

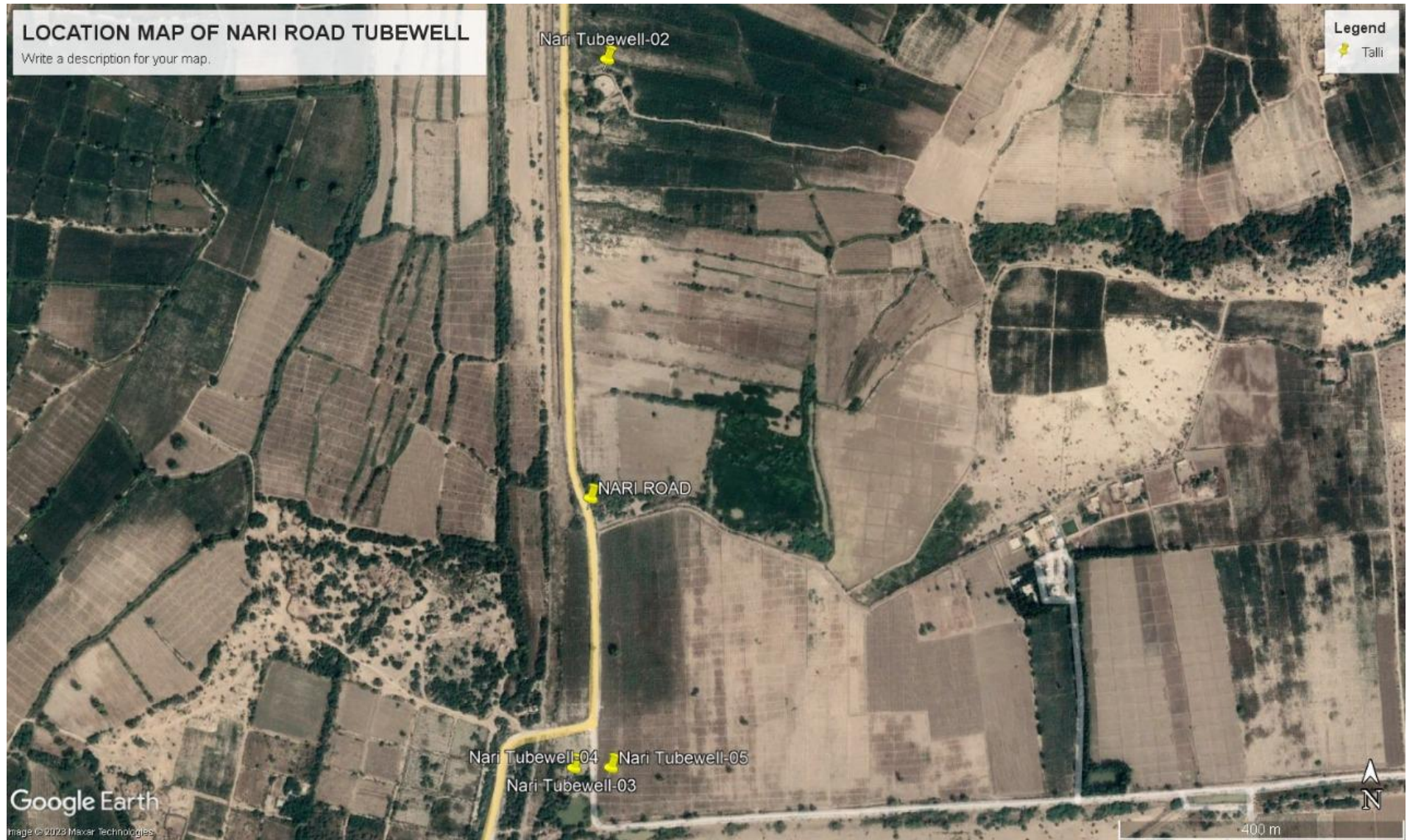


Drawing No. 3 – Location of Sump Well

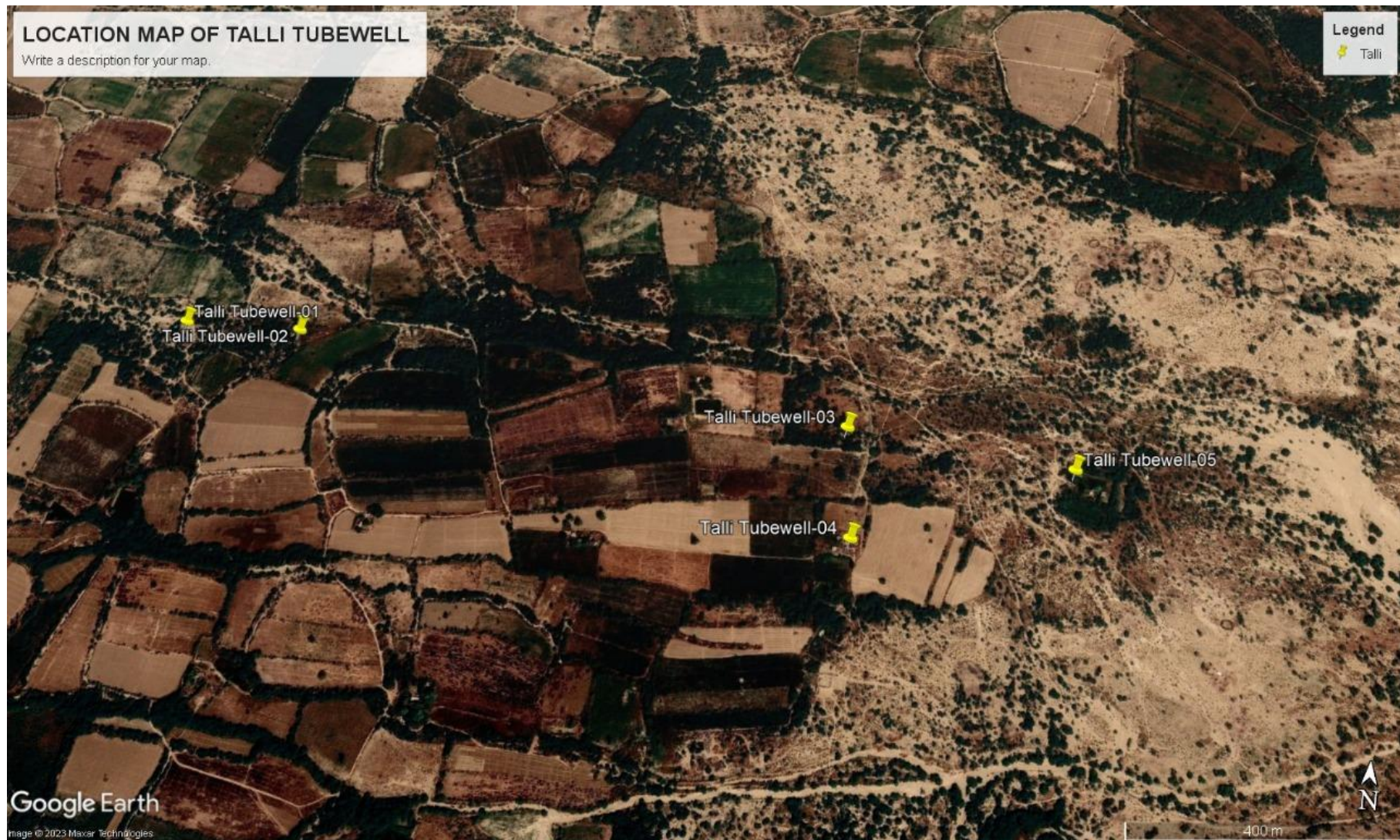


Drawing No. 4 – Location of Sump Well (With Existing Head Regulator)





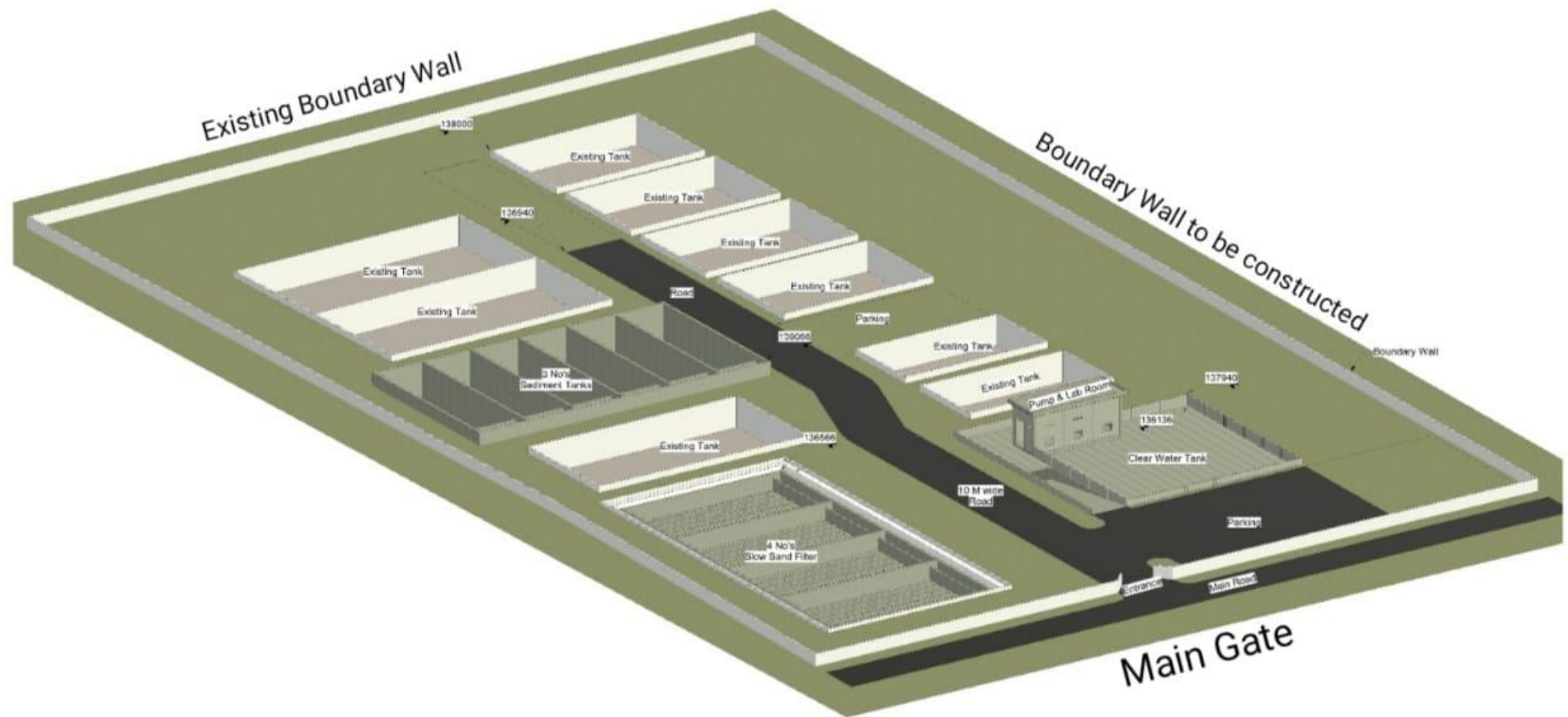
Drawing No. 6 – Location of Nari Road Tube wells



Drawing No. 7 – Location of Talli Tube wells



Drawing No. 8 – Google Map showing Layout Sibi Town WSS



Drawing No. 9 Schematic showing Existing Boundary Wall and Boundary Wall to be Constructed.

5. Inspections and Tests

5.1 Inspections and Tests of Pipelines

5.1.1 Pipe Inspection, Testing & Marking

1. Metallurgical Tests

Metallurgical Tests confirm that the chemical requirements of pipe are as per the material standard.

- Metallurgical Tests are normally known as Micro and Macro pipe inspection & testing.
- Micro Analysis or Chemical Analysis of
 - Raw material
 - Product
 - And Weld ensures that all the alloying elements are within the range as specified in the material standard
- Macro Analysis for Weld will check proper fusion of weld material with pipe material.

There are some Special pipe inspection tests also carried out on the material when it is going to be used in aggressive environments. These tests will ensure that pipe material is able to withstand in such aggressive environments also. Some of the tests are

- Grain size (AS & SS)
- IGC- Intergranular Corrosion Test (SS)
- Ferrite (SS)
- HIC- Hydrogen-induced Cracking
- SSC- Sulfide Stress Corrosion Cracking

2. Destructive test

The mechanical / Destructive test type of pipe inspection confirms the mechanical requirements of pipe are as per the material standard.

In Destructive Testing- a sample from the pipe is cut to performed tests

- The tensile test is done to check yield and ultimate tensile of the pipe. If required by the purchaser or by standard high or low-temperature tensile test are also performed.
- Bend test / Guided bend test are used to check integrity of weld joint
- Flattening test examines ability of plastic deformation in pipe
- Impact test / Charpy V-Notch Test, check the ability of material to withstand under low-temperature conditions
- Creep test is done to check long term effect of temperature under constant load.

3. Pipe Inspection – Hydro Test, NDT, Visual and Dimension

To ensure product quality, during and after the production certain pipe inspection and non-destructive testing are performed on the body & weld of the pipe. These pipe inspections will check whether any physical defects are present in the pipe/weld, which may affect its performance during the service. These testing are

- Flux leakage examination or Magnetic flaw detection
- Eddy current
- Ultrasonic – can be done on full body or only for weld seam
- Radiography (Only for Weld)
- Magnetic particle test for pipe ends & weld seam
- And Positive Material Identification.

5.1.2 Hydrotest of Pipe

Hydrostatic Test or Hydrotest of pipe is carried out to

- Ensure that pipe is 100% leak proof
- It also ensures the ability of pipe to withstand under pressure
- Hydro test pressure is calculated based on equation given in ASTM A530,

$$P = 2St/D \text{ or } S = PD/2t$$

- P = hydrostatic test pressure in psi or Mpa,
- S = pipe wall stress in psi or Mpa,
- t = specified nominal wall thickness, nominal wall thickness corresponding to specified ANSI schedule number, or 1.143 times the specified minimal wall thickness, in. [mm], and
- D = specified outside diameter, outside diameter corresponding to specified ANSI pipe size, or outside diameter calculated by adding $2t$ (as defined above) to the specified inside diameter, in. [mm].

Holding time for the hydro test is minimum 5 sec as per ASTM A530. Pressure is monitored by the computerizing system. For welded pipe inspection, the test pressure should be held for a time, sufficient to permit the inspector to examine the entire length of the welded seam. Hydrostatic test can be waived under certain conditions as set in the ASTM standard

5.1.3 Pipe Visual Inspection

- Visual Inspection is one of the most effective inspection methods used to check overall product quality. During the visual inspection, you will check for overall product finish. You will check for surface imperfections such as mechanical marks, lamination, tears or any other visual imperfections and also check weld defects such as porosity, undercuts, uneven weld bead, and excess or under fill of weld material. Acceptance of these imperfections is as per applicable ASTM standard.

5.1.4 Pipe Dimension Inspection

- Dimension inspection of the pipe is carried out based on the Dimension Standard, final dimension of the pipe must confirm to the standard as specified in the Specifications.

- During dimensional inspection, following to be confirmed with standard
 - ✓ Diameter
 - ✓ Length
 - ✓ Thickness
 - ✓ Straightness
 - ✓ Ovality &
 - ✓ Weight

Permissible Variations depends on manufacturing standard.

5.1.5 Pipe Marking Inspection

Once the pipe is cleared all test and inspection, it is marked as per the standard requirements

- Following shall be marked on pipe
 - Manufacturer logo
 - ASTM material code
 - Material Grade
 - Size
 - Thickness- schedule no.
 - Length
 - Heat No
 - Special marking WR for weld repair or NH for the non-hydro tested pipe.
- These Marking can be done by paint or by Hard punching

5.2 Solar PV Arrays Testing

Solar PV panels are subjected to a variety of tests. Via the solar panel tests, safety and compliance with the minimum quality standards are checked, of which passing is a precondition to getting approval for the solar modules.

Advanced performance and quality tests help the user to choose the right solar panel type.

5.2.1 Solar panel test criteria and procedures

There are two types of solar panel tests, the tests, which check the minimum requirements for the approval and the advanced testing procedures, which assess the quality of solar PV panels.

The first tests check the solar PV panels in accordance with given norms and standards.

The latter examines the quality of solar PV panels and evaluates these using advanced test criteria. These quality tests enable users to compare different solar panel types on the basis of quality or test seals.

The different testing procedures are used for the assessment and appraisal of solar PV panels. They vary in terms of their test and measurement criteria and the use of measurement methods. In this article, we will present the most relevant tests required to get approval for solar PV panels.

5.2.2 Test procedures for the approval of solar PV panels

Certain minimum requirements must be fulfilled to get approval for a solar module. These ensure the safe operation, the suitability of the components and the functionality of solar PV panels.

5.2.3 IEC certification of solar PV panels

One of the most important solar panel testing procedures is the IEC certification. It indicates that the solar PV modules comply with individual safety, quality and durability requirements.

In these tests, the solar PV panels are subject to various loads, which are defined by the so-called ICE standards. The standards were established by the International Electrotechnical Commission (IEC) in Geneva.

The IEC certificate provides the basis for the trading of solar PV panels.

The IEC certification determines the basic solidity of solar PV panels and thereby ensures the functionality and safety of solar PV systems, and so, the essential operating requirements of solar PV panels.

The test certificate IEC 61215 applies to monocrystalline, polycrystalline and thin film solar panels.

During the tests, solar PV panels are subject to various loads. This includes, for example, the impact of external influences, which are generated artificially on the solar panel degradation, what effect mechanical loads have as well as different climatic conditions (heat, cold, humidity, climate change or the UV solar radiation) on the solar PV panels.

A successful passing of the tests is a precondition for the approval for solar PV modules. The solar PV panels have successfully passed the tests if no serious changes occur in their behavior or no significant loss of performance at different climatic conditions is reported.

In addition, when there is no damage of PV modules by mechanical loads.

The test standard IEC 61730 is a security standard for solar PV panels, which distinguishes between three classes of applications: class A for buildings, class B for energy supplier applications and class C for low-voltage applications.

The standard IEC 61730 defines the construction and the specific material requirements with regard to the fire protection of solar PV panels.

The IEC 61730 standard compliance ensures the safe operation during the expected lifetime of the solar PV system. It is also mandatory for approval of solar panel systems in Europe.

Another security standard is the IEC 61140, which concerns the protective insulation of solar PV panels. For this, the solar PV panels are subject to strength tests, such as shock and scratch tests.

The tests are made to find out the suitability of the materials used as well as the leakage currents in the components.

5.2.4 Standard Test Conditions (STC) tests

Another central solar panel test procedure is the standard test conditions-tests (STC-tests), which are run for all solar PV panels.

They enable the evaluation and comparison of different solar panel types, by determining current, voltage and power of solar PV panels under comparable test conditions.

The solar PV modules are subjected to a solar radiation of 1000 W/m^2 , a module temperature of 25°C and an air mass coefficient of 1.5. The determined power is given in Watt peak.

In addition to laboratory tests, the solar PV panels are also exposed to real conditions. In these tests, the investigations occur at the place, where the solar PV panels will be installed, either on the roof of a building or a large open area.

In addition, other criteria become relevant to the performance examination of solar PV panels and are considered in the calculations. These include a minimal solar radiation of 800 W/m^2 , a temperature determination and its consideration by value calculations and the angle of incidence, which is determined with the aid of inclinometer.

5.2.5 NOCT-Test

Another solar panel test procedure is the NOCT-Test. NOCT stands for Normal Operating Cell Temperature.

With the help of NOCT-Tests, loads of the materials of the solar modules are properly evaluated, and the heat radiation to the environment is determined.

NOCT is therefore considered as a standard measure for the assessment of the PV systems components.

The NOCT average values are:

Wind speed 1 m/s (is the lower section of the wind strength 1 ($3,6 \text{ km/h}$))

An irradiance of 800 W/m^2

Air Mass of 1.5

Air Temperature of 20°C

Electrical voltage at no load and in an open-circuit

NOCT is measured in the approval test of solar PV panels.

5.2.6 Carbon Footprint Verification (CFV)

A new solar panel test procedure is the Carbon Footprint Verification (CFV), which is carried out by the standards and certification organization, British Standards Institution (BSI).

The CFV procedure is based on the standards PAS 2050 and ISO 14067. It serves to assess and quantify the carbon footprint.

For this purpose, several stages of a product life cycle are checked, such as the procurement of raw materials, the production processes and the packaging of solar modules until the solar panel recycling.

5.3 Submersible Pumps Tests

5.3.1 Shop Tests

The submersible borehole pumps shall be assembled completely in the shop to ensure correct fitting of all parts and shall be match marked before shipment, unless the pump is shipped completely assembled, to ensure correct assembly in the field. The pump casing shall be tested hydrostatically under a pressure equal to 150 percent of either the sum of the pump shut off head plus the maximum suction head or the maximum working pressure whichever is greater.

The hydrostatic test pressure shall be held for not less than 30 minutes after all leaks have been stopped.

The pumps shall be tested by and at the expense of the supplier to establish that the performance requirements of these Specifications and the supplier's guarantees have been fulfilled. The pumps shall be tested in the manufacturer's shop and the performance tests shall be made with the entire pumping unit at different speeds. Readings shall be taken at a minimum of five capacity points, including one point with plus or minus 2 percent of capacity specified.

The tests shall be conducted in accordance with the accepted practices at minimum speed, full speed, and maximum speed and unless otherwise specified, the procedure and instruments used shall conform to the latest applicable standards.

The test shall be carried out in the presence of the representatives of the Purchaser.

The test shall cover:

- A. Determination of the total head.
- B. Determination of rate of water pumped.
- C. Measurement of input power to the pump or output power of the motor.
- D. Determination of pump efficiency at different speeds.
- E. Preparation of characteristic curve with VFD showing pump efficiency, flow and head.
- F. Measurement of reverse runaway speed.

- G. Determination of NPSH required.
- H. Minimum submergence required.

5.3.2 Operational Tests

Operational tests may be performed by the Purchaser on the pump before the pump is placed in service. If so desired by the Purchaser, the tests shall be repeated one month before the expiry of the defect liability period or guarantee/ maintenance Period.

5.3.3 Performance Tests, Capacity and Efficiency

- A. General: Within two weeks after the operation of the submersible borehole pump with VSD features has been approved by Purchaser, as provided in the Contract, the pumping units shall be tested by and at the expense of the Supplier to determine whether the equipment meets the guarantees as given. If so desired by the Purchaser, the tests shall be repeated one month before the expiry of the Maintenance Period.
- B. Provision in Case of Damage or Wear: Prior to the tests, the submersible borehole pumps having VSD features will be inspected by the Purchaser and the Supplier. Should such inspection disclose any damage or wear has taken place the Supplier shall rectify such damages at his own cost.
- C. Capacity and Efficiency Tests: The capacity and efficiency of the submersible borehole pump with VSD features will be determined for as many different heads within the range of operating heads as possible. The capacities and efficiency at the guaranteed conditions will be determined from smooth curves drawn through the test points.
- D. Conduction of the Tests: The tests will be conducted in accordance with latest applicable Hydraulic Institute Standards.
- E. Determination of Rate of Flow: The rate of flow of water through the submersible borehole pump will be determined by the properly calibrated flow meter.
- F. Determination of Total Head: Total head on submersible borehole the pump (H) will be the difference between the pressure elevation at the pump discharge and the pressure elevation near the entrance to the suction elbow, both corrected for velocity head.
- G. Determination of Power: The electrical input to the motor will be measured by using accurate, sensitive and calibrated, test instruments connected to the permanently installed instrument transformers or as directed by the Purchaser. The input to the pump will be the measured input to the motor minus the mechanical and electrical losses in the motor. The losses in the motor will be determined by separate tests in accordance with the latest standards and test codes of the Institute of Electrical and Electronic Engineers, Inc; and the American National Standards Institute.
- H. Determination of Efficiency Curve: The efficiency curve of the submersible borehole pump will be determined at various frequencies of the input, head and rate of flow of water, all as determined in accordance with the above sub-paragraphs.

- I. Runaway Tests: The submersible borehole pumps will be subject to runaway tests & witnessed by the Purchaser. The tests will be performed under normal operating conditions by interrupting the power supply.

5.4 Procedure to be implied during the Acceptance Tests

The following procedure and checks shall be implied during the inspection and tests.

- Documentation check
- Visual inspections
- Safety and component tests
- System performance tests

The details of tests above inspections and System Performance Tests shall determine whether the system is able to perform to specification in terms of water delivery relative to available solar resources on site, and pumping head conditions on site, etc.

Section VI. Sample Forms

Sample Forms

1. BID FORM AND PRICE SCHEDULES.....	200
3. PERFORMANCE SECURITY FORM	222
4. MANUFACTURER’S AUTHORIZATION FORM	223

1. Bid Form and Price Schedules

Date: _____
IFB No: _____1

To: *[name and address of Purchaser]*

Gentlemen and/or Ladies:

Having examined the bidding documents including Addenda Nos. *[insert numbers]*, the receipt of which is hereby duly acknowledged, we, the undersigned, offer to supply and deliver *[description of goods and services]* in conformity with the said bidding documents for the sum of *[total bid amount in words and figures]* or such other sums as may be ascertained in accordance with the Schedule of Prices attached herewith and made part of this Bid.

We undertake, if our Bid is accepted, to deliver the goods in accordance with the delivery schedule specified in the Schedule of Requirements.

If our Bid is accepted, we will obtain the guarantee of a bank in a sum equivalent to _____ percent of the Contract Price for the due performance of the Contract, in the form prescribed by the Purchaser.

We agree to abide by this Bid for a period of 91 days from the date fixed for Bid opening under Clause 22 of the Instructions to Bidders, and it shall remain binding upon us and may be accepted at any time before the expiration of that period.

Until a formal Contract is prepared and executed, this Bid, together with your written acceptance thereof and your notification of award, shall constitute a binding Contract between us.

Commissions or gratuities, if any, paid or to be paid by us to agents relating to this Bid, and to contract execution if we are awarded the contract, are listed below:

Name and address of agent	Amount and Currency	Purpose of Commission or gratuity
_____	_____	_____
_____	_____	_____
(if none, state "none")		

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

Dated this _____ day of _____ 20_____.

[signature]

[in the capacity of]

Duly authorized to sign Bid for and on behalf of _____

BILL OF QUANTITIES

**BALUCHISTAN INTEGRATED WATER RESOURCES MANAGEMENT
AND DEVELOPMENT PROJECT (BIWRMDP)**

**PROCUREMENT OF GOODS FOR CONSTRUCTION OF
SIBI TOWN WATER SUPPLY SCHEME**

GRAND SUMMARY

Bill No.	Description	Total Cost (Pak Rs)
1	General Items	1,820,000
2	Implementation of ESMP Checklist	990,000
3	Total Price of Goods	
4	Total Price of Related Services	
Grand Summary (Carried Forwarded to Bid Form)		

**BALUCHISTAN INTEGRATED WATER RESOURCES MANAGEMENT
AND DEVELOPMENT PROJECT (BIWRMDP)**

PROCUREMENT OF GOODS FOR CONSTRUCTION OF SIBI TOWN WATER SUPPLY SCHEME

Bill 1 - General Items

BILL OF QUANTITIES

Item No.	Description	Quantity	Unit	Unit Rate (Pak Rs)	Amount (Pak Rs)
1.1	Provision of one (1) 4WD vehicles / Jeeps (1300cc), Jimny or Equivalent in good running condition for use by Supervision Staff of the Project Manager / Employer in accordance with specification during construction period.	PS	-	600,000	600,000
1.2	Provision of POL, Service, repair and maintenance costs for the motorcycle provided under the contract BOQ item No 1.2, all in accordance with the specifications during construction period	PS	-	300,000	300,000
1.3	Provision of Residential cum Office Accommodation for Project Manager's support staff in accordance with the specifications for Construction period.	PS	-	480,000	480,000
1.4	Provision of messing facilities for the staff of Project Manager for Construction period.	PS	-	240,000	240,000
1.5	Provision of Furnishing and Equipment for Residential cum Office Accommodation for Project Manager's support staff in accordance with the specifications for Construction period.	PS	-	200,000	200,000
Total for Bill 1 (Carried to Grand Summary)					1,820,000

**BALUCHISTAN INTEGRATED WATER RESOURCES MANAGEMENT
AND DEVELOPMENT PROJECT (BIWRMDP)**

PROCUREMENT OF GOODS FOR CONSTRUCTION OF SIBI TOWN WATER SUPPLY SCHEME

Bill 2 - Implementation of ESMP Checklist

BILL OF QUANTITIES

Item No.	Description	Quantity	Unit	Unit Rate (Pak Rs)	Amount (Pak Rs)
2.1	HSE and Social Supervisor	6	Month	50,000	300,000
2.2	Preparation and Implementation of: Best practices/Plan for traffic, HSE, Pollution and Waste, Code of conduct, basic provisions to staff (CESMP)	1	LS	300,000	300,000
2.3	First Aid Boxes & Fire fighting equipment (Using and Maintaining during construction period)	1	No	40,000	40,000
2.4	Water Testing, Ambient Air Testing, Noise Monitoring (Each)	3	Samples	75,000	225,000
2.5	Provision and Use of PPEs to Staff	1	LS	25,000	25,000
2.6	Trainings at each site (Environmental and Social Mitigations and Implementation)	2	LS	50,000	100,000
Total for Bill 2 (Carried to Grand Summary)					990,000

Bill 3 - Price Schedule: Goods

		Date: _____					
		NCB No: _____					
		Alternative No: _____					
		Page No _____ of _____					
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>
Line Item No.	Description of Goods	Delivery Date	Qty	Unit	Unit price DDP (Pak Rs)	Total price (Col. 4 x 6) (Pak Rs)	Country of Origin
A	HDPE Main Pipe Line						
3.1	Supply of HDPE pipes density 700-960 kg/cu.m and carbon black contents > 2% with DIN- 8074, 8075 or PS-3580:1997(rev.) ISO 9001-2000 pressure classification of PE -100 (black) for water PN-10 including cost of specials, and complete with all accessories for installation in all respects.						
a	315 mm outer dia PN 10 Butt Fusion Joint		1,530	R.M			
b	200 mm outer dia PN 10 Butt Fusion Joint		1,900	R.M			
3.2	Supply of approved quality flanged C.I. Gate Valve of BSS quality and weight PN-15 for PE pipe line including cost of jointing material, flanges, hardware etc.						
a	Dia 315 mm		1	Each			
b	Dia 200 mm		1	Each			
B	Pumping Machinery						
3.3	Supply of clear water vertical Turbine pump (KSB or equivalent) as per requirement coupled with compatible electric motor, including cable compatible MCU to operate motor, cost include C.I gate valve and C.I. non-return valve and 6" dia MS delivery pipe with each pump set connected to the 18" dia MS Manifold. The quoted cost shall include bend, suction line, delivery main with pressure gauge, vibration insulator, etc complete in all respect as desired by Engineer In charge. Control panel shall operate all pumps, two in parallel and on manual -auto-off positions shall have all protections, i-e dry-run, thermal and phase. Cost includes control sensors/ float sensors etc. pump motor with high efficiency and compatible to operate on solar power as well.						
	Discharge (Q) = 600 gpm.						
	Head (H) = 75 M						
	Horse Power = 50						
			4	Sets			

Bill 3 - Price Schedule: Goods

		Date: _____					
		NCB No: _____					
		Alternative No: _____					
		Page No _____ of _____					
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>
Line Item No.	Description of Goods	Delivery Date	Qty	Unit	Unit price DDP (Pak Rs)	Total price (Col. 4 x 6) (Pak Rs)	Country of Origin
3.4	Supply and fabrication of MS 18" dia pipes (PN-15) as manifold with flanged connections for 4 Nos pump delivery pipes of 6" dia. The cost includes all hardware and welding etc. complete with outlet flanged connection upto outside pump well.		20	R.M			
3.5	Supplying of C.I Air release valve double orifice type PN-10						
a	Dia 50mm (2 Inches)		1	Each			
b	Dia 75mm (3 Inches)		1	Each			
3.6	Supply of Solar PV Arrays/ modules of 40 kWp. The Solar PV arrays/ modules shall be "crystalline" type, IEC 61215:2005 certified by German Laboratory TUV/ VDE, ready and complete with all accessories for installation in all respects.		40,000	Per Watt			
3.7	Supply, Install, connect, test and commission of SOLAR MOUNTING STRUCTURE & accessories (Movable).		40,000	Per Watt			
3.8	Supply of Solar Panel/ Operational Panel having appropriate Inverter, MPPT, Combiner box, DC Energy Meter, DC cables, Hour meter for tube well operation, automatic/ manual control for submersible motor-pump, VFD, main Cu Bus bar (3-Phase+N+E) & TP MCCB adjustable (Main incoming Circuit Breaker) and outgoing MCBs with spares available, Motor-pump set protections (Over Current, Short circuit, Under Current, Under & Over Voltage), DC and AC incoming & outgoing Power cables & wires etc. with all other required accessories. The panel shall be properly compartmentalized and free standing ready and complete with all accessories for installation in all respects.		1	Set			
3.9	Supply of Chlorination System with complete accessories including two chlorine drums with motorised mixer (3/4 HP) with outlet having tank capacity of 100 gallons. Each from Clean Water Tank to Distribution System.		1	Set			

Bill 3 - Price Schedule: Goods

		Date: _____					
		NCB No: _____					
		Alternative No: _____					
		Page No _____ of _____					
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>
Line Item No.	Description of Goods	Delivery Date	Qty	Unit	Unit price DDP (Pak Rs)	Total price (Col. 4 x 6) (Pak Rs)	Country of Origin
3.10	Supply of Emergency Diesel generating set of output 100 KVA at Treatment Plant (continuous), three phase, 4 wire, 380-415 volts, 50 Hz water cooled engine including alternator, skid mounted, electrical start with battery, generator circuit breaker, silencer, anti vibration pads, control panel with auto mains failure functions, auto synchronizing, auto load sharing functions, power and control cables, common push bar panel and installation material complete in all respect as per specifications.		1	Set			
3.11	Supply of Transformer 200 kVA complete in all respect according to specification		1	Set			
C	Rehabilitation of Existing Tube Wells						
3.12	Supply of Transformers 50 kVA, complete with all respect for Tube well No. 1 to 6, complete in all respect according to specification		6	Set			
3.13	Supply of Transformers 100 kVA, complete with all respect for Tube well, complete in all respect according to specification		1	Set			
3.14	Supply of Submersible Pump set of KSB, Grandfos or approved equivalent (similar specifications), complete in all respects including all taxes. Submersible Pump Set, discharge @200 gpm. at head of 120m and Hp 30. The cost includes compatible MCU submersible cable etc completism shall have all protections.		5	No			
Sub Total Bill 3 - Price Schedule for Goods							

Bill 4 - Price and Completion Schedule - Related Services

		Date: _____					
		NCB No: _____					
		Alternative No: _____					
		Page No _____ of _____					
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>
Service No.	Description of Services	Country of Origin	Completion Date at Final Destination	Qty	Unit	Unit price (Pak Rs)	Total Price per Service (Col. 5 x 7 or estimate) (Pak Rs)
A	HDPE Main Pipe Line						
4.1	Excavation of trenches for water supply pipelines any depth from ground level including trimming, dressing sides, levelling the bed of trenches to correct grade and cutting pit for joints in hard soil. The unit rate shall include refilling / backfilling pipe trench in layers with excavated stuff in 6" thick layers i/c watering, ramming to full compaction etc complete. Excavated stuff should be free of boulders, rocks etc.						
a	Ordinary Soil			10,240	Cu.m		
b	Hard Soil			2,560	Cu.m		
c	Excavation with dewatering			750	Cu.m		
4.2	Cutting trenches through bituminous road for laying pipe etc. in any width and upto required depth including dismantling kerb stones, edge stones or channels, and restoring road to previous condition by replacing soling stones (old and 10% new) with hand refilling with (old and 25% new) ballast blinded with murum, watering and ramming complete, refixing edge stone, kerb stones in cement mortar 1:3 including recarpeting with (consolidated) asphalt macadam as per specification (cost of new stone, ballast and new murum is inclusive).(including royalty of Quarry).			90	Cu.m		
4.3	Providing and spreading granular sand cushion (100 mm) thick under pipe, where ever loose foundation or weak soil is encountered and as per approval of engineer.			2,000	Sq.m		
4.4	Providing concrete thrust blocks (as per design on the turning points of the pipe @ 45° (1:2:4) - 90° as per approved drawing.			8	Cu.m		

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Service No.	Description of Services	Country of Origin	Completion Date at Final Destination	Qty	Unit	Unit price (Pak Rs)	Total Price per Service (Col. 5 x 7 or estimate) (Pak Rs)
4.5	Laying, cutting, jointing, testing and disinfecting of HDPE pipes density 700-960 kg/cu.m and carbon black contents > 2% with DIN- 8074, 8075 or PS-3580:1997(rev.) ISO 9001-2000 pressure classification of PE -100 (black) for water PN-10 including cost of jointing material, and complete with all accessories for installation in all respects. (Pipes supplied as per Item 3.1)						
a	315 mm outer dia P N 10 Butt Fusion Joint			1,530	R.M		
b	200 mm outer dia P N 10 Butt Fusion Joint			1,900	R.M		
4.6	Providing chambers 30" x 18" x 56" as per approved design for sluice valve 3" to 12" dia. with 18" dia. C.I.cover and frame weighing 88.9 Kg. fixed in 4" thick R.C.C. 1:2:4 slab with re-steel 5 lbs./cu.ft and 9" thick burnt brick masonry walls in 1:6 cement sand mortar, 6" thick cement concrete 1:3:6 in foundation, 1" thick concrete 1:2:4 flooring, 1/2" thick plaster in 1:3 cement sand mortar to all inner wall surfaces, including providing and fixing C.I. foot rest at every 12" beyond 30" depth including curing, excavation, back filling and disposal of surplus earth.			2	Each		
4.7	Fixing of approved quality flanged C.I. Gate Valve of BSS quality and weight PN-15 for PE pipe line including cost of jointing material, flanges, hardware etc. (Dia 200 mm). (C.I. Gate Valve supplied as per Item 3.2)						
	Dia 315 mm			1	Each		
	Dia 200 mm			1	Each		
4.8	Making and maintaining traffic diversion during construction, including supplying necessary barriers, notice boards with lighting arrangements & providing temporary crossing wherever necessary.			1	LS	150,000	150,000

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Service No.	Description of Services	Country of Origin	Completion Date at Final Destination	Qty	Unit	Unit price (Pak Rs)	Total Price per Service (Col. 5 x 7 or estimate) (Pak Rs)
4.9	Making connections of filling, supply, drain and at pumping side and pipes of over-head tanks (OHT), including cost of supplying and providing flanges, specials needed, hardware etc complete			10	No		
B	Pumping Machinery						
4.10	Design, installation, testing and commissioning of clear water vertical Turbine pumps (KSB or equivalent) as per requirement coupled with compatible electric motor, including cable compatible MCU to operate motor, cost include C.I gate valve and C.I. non-return valve and 6" dia MS delivery pipe with each pump set connected to the 18" dia MS Manifold. The quoted cost shall include bend, suction line, delivery main with pressure gauge, vibration insulator, etc complete in all respect as desired by Engineer In charge. Control panel shall operate all pumps, two in parallel and on manual -auto-off positions' shall have all protections, i-e dry-run, thermal and phase. Cost includes control sensors/ float sensors etc. pump motor with high efficiency and compatible to operate on solar power as well (Goods supplied under Item 3.3).						
	Discharge (Q) = 600 gpm.						
	Head (H) = 75 M						
	Horse Power = 50						
				4	Sets		
4.11	Design, installation, testing and commissioning of Ms 18" dia pipes as manifold with flanged connections for 4 Nos pump delivery pipes of 6" dia. The cost includes all hardware and welding etc. complete with outlet flanged connection upto outside pump well (Goods supplied under Item 3.4).			20	m		
4.12	Installation, fixing of Supplying of C.I air release valve double orifice type PN-10 (Goods supplied under Item 3.5)						
a	Dia 50mm (2 Inches)			1	Each		

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Service No.	Description of Services	Country of Origin	Completion Date at Final Destination	Qty	Unit	Unit price (Pak Rs)	Total Price per Service (Col. 5 x 7 or estimate) (Pak Rs)
b	Dia 75mm (3 Inches)			1	Each		
4.13	Design, installation, testing and commissioning of complete Solar PV modules including A-Grade Mono Crystalline PV Modules, movable mounting structure and foundation civil work, junction boxes, fuses, DC breakers, wiring, etc. complete upto Solar Pump Inverter, sized at a sizing factor of 1.75 capable of operating two vertical turbine pumps. (Listed under Item 3.3 i-e 50 HP each) at the same time. The unit cost includes plates, compatible control, wiring etc. complete without back-up batteries as per specification (Goods supplied under Item 3.6, 3.7, & 3.8).			1	Set		
4.14	Design, installation and commissioning of Chlorination System with complete accessories including two chlorine drums with motorized mixer (3/4 HP) with outlet having tank capacity of 100 gallons. Each from Clean Water Tank to Distribution System (Goods supplied under Item 3.9).			1	Sets		
4.15	Design, Installation, Testing and Commissioning of Emergency Diesel generating sets of output 100 KVA at Treatment Plant (continuous), three phase, 4 wire, 380-415 volts, 50 Hz water cooled engine including alternator, skid mounted, electrical start with battery, generator circuit breaker, silencer, anti-vibration pads, control panel with auto mains failure functions, auto synchronizing, auto load sharing functions, power and control cables, common pushbar panel and installation material complete in all respect as per specifications (Goods supplied under Item 3.10).			1	Set		
4.16	Design, installation, testing and commissioning Supply of Transformer 200 KVA, complete in all respect according to specifications (Goods supplied under Item 3.11).			1	Set		

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Service No.	Description of Services	Country of Origin	Completion Date at Final Destination	Qty	Unit	Unit price (Pak Rs)	Total Price per Service (Col. 5 x 7 or estimate) (Pak Rs)
C	Rehabilitation of Existing Tube Wells						
4.17	Design, installation, testing and commissioning of Transformers 50 KVA, complete with all respect for Tube well No. 1 to 6, complete in all respect according to specifications (Goods supplied under Item 3.12).			6	Set		
4.18	Design, installation, testing and commissioning Supply of Transformer 100 KVA, complete with all respect for Tube well, complete in all respect according to specifications (Goods supplied under Item 3.13).			1	Set		
4.19	Design, Installation, Testing and Commissioning of Submersible Pumpset of KSB, Grandfos or approved equivalent (similar specifications), complete in all respects including all taxes. Submersible PumpSet, discharge @200 gpm. at head of 120m and Hp 30 . The cost includes compatible MCU submersible cable etc complete. MCU shall have all protections (Goods supplied under Item 3.14).			5	Set		
D	Construction of Pump House (5mx10m)						
4.20	Providing and laying first class solid burnt brick masonry including scaffolding, racking out joints and curing in foundation, substructure and basement i/c cost of testing .			51	Cu.m		
4.21	Providing and laying 1:2:4 in situ cement concrete using shingle or bajri 19mm (3/4") and down gauge in pillars and columns of any shape in super structure including compacting, curing, cost of formwork and its removal in basement and ground floor.			9	Cu.m		
4.22	Providing and laying 1:2:4 in situ cement concrete using shingle or bajri 19mm (3/4") and down gauge in pillars and Beams of any shape in super			11	Cu.m		

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Service No.	Description of Services	Country of Origin	Completion Date at Final Destination	Qty	Unit	Unit price (Pak Rs)	Total Price per Service (Col. 5 x 7 or estimate) (Pak Rs)
	structure including compacting, curing, cost of formwork and its removal in basement and ground floor.						
4.23	Providing and laying (1:2:4) cement concrete using approved coarse sand and crushed aggregate 3/4" (19mm) & down gauge in Roof slab. Compaction and curing			10	Cu.m		
4.24	Providing and fixing double leaf steel door with frame fully paneled with M.S. sheet 1.59 mm (16 gauge) painted with two coats of red oxide paint with brass fitting of approved make including cost of fabrication, iron lugs, cutting holes and making good the damages to walls.			5	Sq.m		
4.25	Providing and fixing hot dipped galvanized fully glazed (with 3 mm glass sheet) partly fixed and partly hung steel windows and ventilators with Z-Section 32 mm (1.25 ²) or as approved by Engineer in Charge, including using approved brass sections oxidized fitting, iron lugs, cutting holes and making good the damages to walls.			5	Cu.m		
4.26	Providing and fixing iron grills as per approved design including welding all sides of the section at the junction and fixing with sunk iron screws, painting with two coats of red oxide paint in masonry or concrete work.			51	Kg		
4.27	Painting with paint mixed at site using ingredients and pigment to produce required texture and shade in two or more coats on steel and iron work over and including the cost of priming coat, surface preparation, removing rust, scales and dust with wire brush in ground floor or basement.			14	Sq.m		
4.28	Cement plaster using coarse sand on soffits of ceiling, cantilever slabs, sides and soffits of beams, in basement or ground floor including making edges, corners and curing.			45	Sqm		

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Service No.	Description of Services	Country of Origin	Completion Date at Final Destination	Qty	Unit	Unit price (Pak Rs)	Total Price per Service (Col. 5 x 7 or estimate) (Pak Rs)
4.29	19 mm (3/4) thick cement plaster on walls and columns in basement, plinth and ground floor including making edges, corners and curing.			71	Sq.m		
4.30	Pointing on brick work with cement sand mortar in plinth and ground floor including raking out joints and curing. Deep ruled pointing in cement sand mortar 1:3 ratio			52	Sq.m		
4.31	Providing and laying 1:2:4 cement concrete floor using aggregate 19 mm and down gauge in ground floor laid in panels using glass strips but excluding the cost of glass strips including consolidation, finishing and curing (Thickness 100mm).			95	Sq.m		
4.32	Providing, fabricating and laying yield strength equal to 60,000 psi reinforcement for all kinds of R.C.C work in foundation, plinth, ground and first floor including the cost of straightening, removal of Rust, cutting, bending, binding, wastage and providing such overlaps as are not shown on the drawings. The cost of binding wire and precast 1:2:4 cement concrete spacer blocks or M.S chair for binding and holding the reinforcement in position is inclusive.			2	Tonne		
4.33	Distempering with Robbialac, ICI, Dulux, Evershine or equivalent synthetic polyvinyl (SPD) Emulsion finish of approved shade in two or more coats over and including the cost of priming coat including preparation of surface viz dusting, sand papering or rubbing with pumice stone filling cracks or holes, if any, removing blisters or other imperfections at any height in ground floor. At least 2.20liter per 10 sqm			116	Sq.m		
	Electrical Works						

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Service No.	Description of Services	Country of Origin	Completion Date at Final Destination	Qty	Unit	Unit price (Pak Rs)	Total Price per Service (Col. 5 x 7 or estimate) (Pak Rs)
4.34	Supply and installation of distribution board, 18 SWG sheet steel enclosure suitable for recess/semi recess mounting and comprising. One incoming 40A, 250V Double Pole load breaker and 1 outgoing 20A & 2 outgoing 10/6A DP Breakers with fuses required protections and indication lights (red, yellow and green)			1	Job		
4.35	Supply and install DC LED bulb 10 watts including installation			5	No		
4.36	Wiring of light circuit length upto 50m from Distribution Board to point \ switch including circuit wiring between switch with 2.5 sq.mm PVC insulated single core 600 / 1000 Volt grade copper conductor cables including concealed installation of PVC pipe 20mm dia & wiring accessories such as bends, elbows, junction boxes, gang switch board with 2 Pole piano type switches and 15/20 A power plugs with 14 SWG copper conductor as Ecc			3	Points		
4.37	Supply and install DC Fan 15-20 watts including installation			1	No.		
4.38	Supply of 5 Amp, 250 Volt moulded, one-way, single pole, flush mounting piano type light control switch. On appropriate size plastic Box tube fixed recessed in wall along with switch box and plate suitable for single switch on a common board.			1	No.		
4.39	Supply and installation of 1.42 m (56") sweep ceiling fan with fan hook and fan regulator complete with all accessories.			1	Point		
4.40	Wiring from point to switch length upto 30m including any switch to switch wiring with 1.5 sq.mm PVC insulated single core copper conductor cables in concealed PVC 20mm dia & with all wiring & pipe accessories such as bends, elbows, junction boxes, with gang switch board with 2 Pole Piano type switches one for each point with 14 SWG copper conductor			4	Points		

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Service No.	Description of Services	Country of Origin	Completion Date at Final Destination	Qty	Unit	Unit price (Pak Rs)	Total Price per Service (Col. 5 x 7 or estimate) (Pak Rs)
	as Ecc.						
E	CONSTRUCTION OF O. H. W. TANK 20,000 GALLONS						
4.41	Excavation in foundation of buildings, bridges, and other structures, depth up-to 4 meters including dagbelling, dressing, refilling around structures with excavated earth, watering and ramming lead upto 30 m, lift upto 1.5 m in hard soil			104	Cu.m		
4.42	Providing and laying 1:4:8 cement concrete using shingle or bajri 19 mm. (3/4") and down gauge in foundation including leveling compacting and curing. Extra for crushed stone			6.00	Cu.m		
4.43	Providing and laying 1:2:4 cement concrete using shingle or bajri 19mm (3/4") and down gauge in underground tank septic tank and underground drain including formwork and its removal ,compacting and curing.			21	Cu.m		
4.44	Providing and laying 1:1.5:3 cement concrete using shingle or bajri 19mm (3/4") and down gauge in underground tank, foundation , septic tank and underground drain including formwork and its removal ,compacting and curing.			11	Cu.m		
4.45	Providing and laying 1:2:4 cement concrete using shingle or bajri 19mm (3/4") and down gauge in Bracing Beams , underground tank , septic tank and underground drain including formwork and its removal ,compacting and curing.			20	Cu.m		
4.46	Providing and laying 1:2:4 cement concrete using shingle or bajri 19mm (3/4") and down gauge in columns , underground tank , septic tank and underground drain including formwork and its removal ,compacting and curing.			12	Cu.m		

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Service No.	Description of Services	Country of Origin	Completion Date at Final Destination	Qty	Unit	Unit price (Pak Rs)	Total Price per Service (Col. 5 x 7 or estimate) (Pak Rs)
4.47	Providing and laying 1:2:4 cement concrete using shingle or bajri 19mm (3/4") and down gauge in slab underground tank septic tank and underground drain including formwork and its removal, compacting and curing (Top Slab).			8	Cu.m		
4.48	Providing and laying 1:2:4 cement concrete using shingle or bajri 19mm (3/4") and down gauge in bottom slab , including formwork and its removal ,compacting and curing.			18	Cu.m		
4.49	Providing and using concrete additives and chemical (a) pudllo or similar (1 cum = 2.5 kg)			67	Kg		
4.50	Providing Laying, cutting, jointing, testing and disinfecting G.I pipe line including special's cost of painting 2 coats for inlet and outlet. (110 mm Dia Pipe)			25	R.M		
4.51	Providing Laying, cutting, jointing, testing G.I pipe line including specials and the cost of painting 2 coats for OverFlow. (G.I Pipe Square 150mm)			15	R.M		
4.52	Supply and fitting cast iron manhole cover with frame weighing not less then (10.25 lbs/sq.ft.) 50 kg/sq.m (60 cm (24") Square)			1	Each		
4.53	Providing and fixing Sluice Valve at incoming pipe and outgoing pipe of the tank. .						
	Valve (110mm)			2	Each		
	Valve (150mm)			1	Each		
4.54	Providing, fabricating and laying yield strength equal to 60,000 psi reinforcement for all kinds of R.C.C work in foundation, plinth, ground and first floor including the cost of straightening, removal of Rust, cutting, bending, binding, wastage and providing such overlaps as are not shown on the drawings. The cost of binding wire and precast 1:2:4 cement concrete spacer blocks or M.S chair for binding and holding the reinforcement in position is inclusive.			13	Tonne		

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Service No.	Description of Services	Country of Origin	Completion Date at Final Destination	Qty	Unit	Unit price (Pak Rs)	Total Price per Service (Col. 5 x 7 or estimate) (Pak Rs)
4.55	Filling, watering and ramming earth under floors. b) With new earth excavated from outside, lead upto 30m and lift upto 1.5m (Including excavation)			38	Cu.m		
4.56	Providing and laying 1:2:4 cement concrete using shingle or bajri 19mm (3/4") and down gauge in sills and bed plates including formwork and its removal ,compacting and curing.			4	Cu.m		
4.57	Providing and fixing M.S angle iron 1/1/2" x 1/1/2" x 1/4" edge protector nozing for steps of stairs having hold fast of 1/4" dia M.S bar 6" long welded at 10" c/c or 3 Nos. in each step and embeded in cement concrete on steps			35	R.M		
F	CONSTRUCTION OF BOUNDARY WALL (500 m)						
4.58	Excavation in foundation of buildings, bridges, and other structures, depth up-to 4 meters including dagbelling, dressing, refilling around structures with excavated earth, watering and ramming lead upto 30 m, lift upto 1.5 m in hard soil			150	Cu.m		
4.59	Providing and laying 1:4:8 cement concrete using shingle or bajri 19 mm. (3/4") and down gauge in foundation including leveling compacting and curing. Extra for crushed stone			27	Cu.m		
4.60	Providing and laying (1:2:4) in situ cement concrete in column's wall & Piers etc upto any thickness using crushed stone size 19mm,3/4 & down gauge including compacting curing cost of formwork and its removal.			120	Cu.m		
4.61	Providing and laying first class solid burnt brick masonry including scaffolding, racking out joints and curing in superstructure andi/c cost of testing .			325	Cu.m		
4.62	19mm thick 1:4 cement plaster using coarse sand on walls and columns in basement, plinth and ground floor including making edges, corners and curing			3,000	Sq.m		

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Service No.	Description of Services	Country of Origin	Completion Date at Final Destination	Qty	Unit	Unit price (Pak Rs)	Total Price per Service (Col. 5 x 7 or estimate) (Pak Rs)
4.63	Providing, fabricating and laying yield strength equal to 60,000 psi reinforcement for all kinds of R.C.C work in foundation, plinth, ground and first floor including the cost of straightening, removal of Rust, cutting, bending, binding, wastage and providing such overlaps as are not shown on the drawings. The cost of binding wire and precast 1:2:4 cement concrete spacer blocks or M.S chair for binding and holding the reinforcement in position is inclusive.			6	Tonne		
4.64	Providing and fixing steel grated double leaf door with locking arrangement, angle iron 5mx3mx10mm frame, middle strip, 6mm thick gusset plate 75mm x 75mm at each edge and 19mm M.S square or round bars at 100mm c/c including two coats of red oxide paint. M.S round bars (19 mm) dia						
	Main Gate (5m x 3m)			15	Sqm		
	Wicket Gate (1.20 x 3m)			4	Sqm		
4.65	Dismantling brickwork in lime or cement mortar greater than 9" width			35	Cu.m		
Sub Total Bill 4 - Price & Completion Schedule - Related Services							

It is hereby confirmed that the specifications of offered above mentioned items, are fully compliant to the technical specifications provided in Section V of bidding document.

Name of Bidder / Firm:

Signature _____

Date: _____

Seal:

2. Contract Form

THIS AGREEMENT made the _____ day of _____ 19____ between *[name of Purchaser]* of *[country of Purchaser]* (hereinafter called “the Purchaser”) of the one part and *[name of Supplier]* of *[city and country of Supplier]* (hereinafter called “the Supplier”) of the other part:

WHEREAS the Purchaser invited bids for certain goods and ancillary services, viz., *[brief description of goods and services]* and has accepted a bid by the Supplier for the supply of those goods and services in the sum of *[contract price in words and figures]* (hereinafter called “the Contract Price”).

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 referred to.
2. The following documents shall be deemed to form and be read and construed as part of this Agreement, viz.:
 - (a) the Bid Form and the Price Schedule submitted by the Bidder;
 - (b) the Schedule of Requirements;
 - (c) the Technical Specifications;
 - (d) the General Conditions of Contract;
 - (e) the Special Conditions of Contract; and
 - (f) the Purchaser’s Notification of Award.
3. In consideration of the payments to be made by the Purchaser to the Supplier as hereinafter mentioned, the Supplier hereby covenants with the Purchaser to provide the goods and services and to remedy defects therein in conformity in all respects with the provisions of the Contract
4. The Purchaser hereby covenants to pay the Supplier in consideration of the provision of the goods and services and the remedying 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 hereto have caused this Agreement to be executed in accordance with their respective laws the day and year first above written.

Signed, sealed, delivered by _____ the _____ (for the Purchaser)

Signed, sealed, delivered by _____ the _____ (for the Supplier)

3. Performance Security Form

To: *[name of Purchaser]*

WHEREAS *[name of Supplier]* (hereinafter called “the Supplier”) has undertaken, in pursuance of Contract No. *[reference number of the contract]* dated _____ to supply *[description of goods and services]* (hereinafter called “the Contract”).

AND WHEREAS it has been stipulated by you in the said Contract that the Supplier shall furnish you with a bank guarantee by a reputable bank for the sum specified therein as security for compliance with the Supplier’s performance obligations in accordance with the Contract.

AND WHEREAS we have agreed to give the Supplier a guarantee:

THEREFORE, WE hereby affirm that we are Guarantors and responsible to you, on behalf of the Supplier, up to a total of *[amount of the guarantee in words and figures]*, and we undertake to pay you, upon your first written demand declaring the Supplier to be in default under the Contract and without cavil or argument, any sum or sums within the limits of *[amount of guarantee]* as aforesaid, without your needing to prove or to show grounds or reasons for your demand or the sum specified therein.

This guarantee is valid until the _____ day of _____ 19____.

Signature and seal of the Guarantors

[name of bank or financial institution]

[address]

[date]

4. Manufacturer's Authorization Form

[See Clause 13.3 (a) of the Instructions to Bidders.]

To:

WHEREAS *[name of the Manufacturer]* who are established and reputable manufacturers of *[name and/or description of the goods]* having factories at *[address of factory]*

do hereby authorize *[name and address of Agent]* to submit a bid, and subsequently negotiate and sign the Contract with you against IFB No. *[reference of the Invitation to Bid]* for the above goods manufactured by us.

We hereby extend our full guarantee and warranty as per Clause 15 of the General Conditions of Contract for the goods offered for supply by the above firm against this Invitation for Bids.

[signature for and on behalf of Manufacturer]

Note: This letter of authority should be on the letterhead of the Manufacturer and should be signed by a person competent and having the power of attorney to bind the Manufacturer. It should be included by the Bidder in its bid.

Section VII. Eligibility for the Provision of Goods, Works, and Services in Bank-Financed Procurement

Public Information Center

Eligibility for the Provision of Goods, Works and Services in Bank-Financed Procurement

In accordance with paragraph 1.8, of the *Guidelines: Procurement under IBRD Loans and IDA Credits*, dated May 2004, the Bank permits firms and individuals from all countries to offer goods, works and services for Bank-financed projects. As an exception, firms of a country or goods manufactures in a country may be excluded if:

Para 1.8 (a) (i): as a matter of law or official regulation, the Borrower's Country prohibits commercial relations with that country, provided that the Bank is satisfied that such exclusion does not preclude effective competition for the supply of the Goods or works required, or

Para 1.8 (a) (ii): by an Act of compliance with a Decision of the United Nations Security Council taken under chapter VII of the Charter of the United Nations, the Borrower's Country prohibits any import of goods from that country or any payments to persons or entities in that country.

2. For the information of borrowers and bidders, at the present time firms, goods and services from the following countries are excluded from this bidding

(a) With reference to Paragraph 1.8 (a) (i) of the Guidelines:

As per Pakistani Government Laws and foreign policy. Specifically, the bidders from India and Israel will not be entertained.

(b) With reference to Paragraph 1.8 (a) (ii) of the Guidelines:

As per United Nations Security Council's current policy