POWER GRID BANGLADESH PLC

Tender Documents
For
Procurement of

Power Transmission Strengthening and Integration of Renewable Energy Project (PTSIREP)

Design, Supply, Installation, Testing & Commissioning of 132kV Transmission Lines on turnkey basis (Package-5)

Volume 2 of 3

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OCB No. : **POWERGRID/ADB/132kVTLS/PTSIREP/PACKAGE-5**

Country : Peoples Republic of Bangladesh

Employer:

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SCOPE OF WORKS

1. Scope of Works and General Information

1.1 General

1.2.1. The extent of supply is described in the following clauses and in the respective sections of the specification. All work not expressly called for in the specification, but necessary for the completion of the work shall be performed and furnished by the Contractor at no additional cost to the Employer.

1.2.2. The Contract shall comprise design, manufacturing, testing, supply, insurance, delivery to site of towers, poles, phase conductors, earthwire, OPGW including all associated fittings, complete insulator sets, phase and earthwire tension and non-tension joints and clamps, vibration dampers, spacer dampers, erection, setting to work, testing and the replacement and/or adjustment of defective material and workmanship for the duration of the warranty period detailed in the "Extent of Supply" and the associated **Annex 1-1.**

1.2.3. Generally, the contract comprises design of towers, poles and foundations etc. as mentioned in the specification. But some cases existing proto type load tested towers and poles are used to construct the line. In such case, the Contractor is not required to design the relevant structure. The requirements of design activities are specifically mentioned in the **Annex 1-1**.

1.2 Extent of Supply

1.2.1. Supply, delivery and construction of transmission line(s) as mentioned in the specification and in **Annex 1-1**.

1.2.2. The various items of work are described very briefly in the relevant Price Schedules. The various items of the Schedule of Prices shall be read in conjunction with the corresponding sections in the Technical Specifications including amendments and, additions, if any. The Bidder's quoted rates shall be based on the description of activities in the Schedule of Prices as well as other necessary operations required to complete the works detailed in these Technical Specifications.

1.2.3. The **unit rates** quoted shall include minor details which are obviously and fairly intended, and which may not have been included in these documents but are essential for the satisfactory completion of the various works.

1.2.4. The unit rate quoted shall be inclusive of all plant equipment, men, material skilled and unskilled labour etc. essential for satisfactory completion of various works.

1.2.5. All **measurements for payment** shall be in S.I. units, lengths shall be measured in meters corrected to two decimal places. Areas shall be computed in square meters & volume in cubic meters rounded off to two decimals.

1.2.6. The Bidder shall submit his offer taking into consideration that the towers/poles designs /drawings shall be approved by the Employer. Bidder shall quote the unit rates for various items of towers as per units mentioned in appropriate Price Schedule. However, payment of these items identified in the price schedules shall be made as follows:

- Towers / poles:
  - Supply items On supply of respective complete tower/pole
  - Erection items On supply of respective complete tower/pole
- Foundation items: On completion of the respective foundation in all respects

1.2.7. All the **raw materials** such as steel, zinc for galvanising, reinforcement steel, cement, coarse and fine aggregates for tower foundation, coke and salt for tower earthing etc. are included in the Contractor's scope of supply.

1.2.8. Bidders shall also indicate in the offer, the sources from where they propose to procure the fasteners, anti-theft fasteners, step bolts, hangers, D-shackles etc., tower accessories, aviation signal (if required) etc.

1.2.9. In hilly terrain and thick forest or area with site constraints, where deployment of tension stringing machine is not possible, manual stringing may be adopted after getting approval of Employer's site Engineer. The Contractor shall deploy appropriate tools/ equipment / machinery to ensure that the stringing operation is carried out without causing damage to conductor / earth wire /OPGW and conductor / earthwire/OPGW is installed at the prescribed sag tension as per the approved stringing charts.

1.3 Details of Transmission Line Routes and Terrain

1.3.1 The detailed survey shall be carried out using Total stations, DGPS, etc. along the approved route alignment. As an alternative, the Contractor may also use ALTM (Airborne Laser Terrain Modelling) techniques of equal or better accuracy for the detailed survey.

1.3.2 Bidders may, however, visit the line route to acquaint themselves with terrain conditions, approach /accessibility to the site, salient features of the route and associated details of the proposed transmission lines. Employer may also arrange joint site visit of line route in Bangladesh for all the interested Bidders who intend to participate in the bidding and have purchased the biding documents.

1.4 Location Details and Terminal Points

Please refer to **Annex 1-2** for terminal points.

The Contractor shall have to construct these transmission line(s) completely up to dead end towers on either ends. Stringing shall also be carried out from dead end tower to terminal gantry / tower.

1.5 Estimated and Final Quantities

The quantities set out in the schedules are, unless otherwise defined, estimated quantities of the Works required. They are not to be assumed as the actual and final quantities to be executed by the Contractor in fulfilment of his obligations under the contract.

Manufacturing and delivery quantities are to be established by the Contractor, and agreed upon by the Employer, within three (3) months from the date of signing of the Contract.

1.6 Modifications

The transmission line shall be completely in accordance with the Specification and associated design and general arrangement/outline drawings. Any modifications thereto are subject to written confirmation by the Employer/Engineer.

1.7 Terminal Points

The terminal points for the supply and/or installation of the transmission line are defined in **Annex 1-2.**

1.8 Programme of Work

a. Within 4(four) weeks of signing of the contract the Contractor shall submit to the Employer for approval, 5(five) copies of a bar chart detailing the plant manufacture, testing, delivery and erection programme (as appropriate) for the complete Contract Works.

b. The bar chart shall indicate the various phases of work for all appropriate items of the Contract, from commencement of the Contract to its final completion e.g. design, survey, approval of drawings, ordering of materials, manufacture, testing, delivery, erection and commissioning. The bar chart shall, when appropriate, allow the requisite periods of approval by the Employer, and/or any other regulatory body.

c. If at any time during the execution of the contract it is found necessary to modify the approved bar chart, the Contractor shall inform the Employer and submit a modified bar chart for approval. Such approval is not deemed to be consent to any amendments to the contractual completion date(s).

d. Modifications that may affect site work and associated local arrangements must provide a sufficient notice period to allow for any necessary re-arrangements. It should be recognised that where certain power line outages for crossing purposes have been specified, it may not be possible for these to be replanted due to system operational constraints and this should be allowed for in the overall programme.

e. The Employer intends that access will be given to a reasonable number of sites to provide continuity of work. However, the Contractor shall accommodate reasonable delays in access to

some individual sites that may prevent sequential foundation installation and support erection work being carried out. Provided he has overall continuity of work, this shall not affect the Contractor's programme.

1.9 Safety Measures

The Contract Price shall include the cost for all necessary safety and health procedures to be taken by Contractor and Sub-Contractors under the Project, including following safety measures (not limited to):

- The Contractor shall submit to the Project Manager the work program including concrete safety plans to be done by Contractor (and Sub-Contractors) for protection of general public from accidents and for prevention of traffic accident in the project sites.
- “Health & Safety (Accident Prevention) Officer” shall be continuously stationed in the project construction site throughout the construction period.
- In case power shutdown of existing facility of Power Grid Bangladesh/PDB/REB is required for Contractor’s works, the Contractor shall submit a safety and work plan and request the power outage at an appropriate time, subject to approval of the Project Manager.
- The Contractor shall immediately notify to the Project Manager in case any fatal, major or other accident, which may involve serious injuries, occurs during the period throughout implementation of Project.

1.10 Coordination and Cooperation with other Contracts

a. The Contractor shall cooperate with the Employer and other contractors to ensure the satisfactory completion of the Project.
b. The Contractor shall be responsible for design on the Plant interfacing with any items of equipment which will be installed by other contractor(s), when needed.
c. The Project Manager may call a coordination meeting(s) with other contractors. The Contractor shall dispatch qualified engineer(s) and settle all design parameters, interface conditions and other matters by these coordination meetings. The necessary expenses such as round-trip international air ticket, accommodation, inland travel charge, etc shall be borne by the Contractor, and such a cost shall be deemed to be included in the Contract Price.

1.11 Inspection

Please refer to Clause no 18.1.11 of section 18 of Technical Specification of Bidding Document.

Annex 1-1: Scope and Extent of Definite Works

Design, Supply, Installation, Testing & Commissioning of 132kV Transmission Lines on Turnkey Basis (Package-5).

1. The following transmission lines will be constructed under the above contract:

(i) Satkhira-Paikgacha 132kV double circuit transmission line, (Approx. 30km) using Single ACSR Grosbeak Conductor per phase, one 7x3.25 galvanized steel earthwire equivalent OPGW.

Approx. 1 km at each end of the line (total approx. 2km) shall be built on four circuit towers with two circuits strung to facilitate future line entry in the respective substations to minimize the right of way.

(ii) Bhandaria-Mathbaria 132kV double circuit transmission line (Approx. 32km) using Single ACSR Grosbeak Conductor per phase, one 7x3.25 galvanized steel earthwire equivalent OPGW.

Approx. 1 km at Mathbaria end of the line shall be built on four circuit towers with two circuits strung to facilitate future line entry in the respective substations to minimize the right of way. At Bhandaria end, this Bhandaria-Mathbaria 132kV double circuit transmission line shall use the four circuit towers of 132kV Bagherhat-Pirojpur-Bhandaria transmission line and shall be terminated at the gantry currently used Barishal-Bagherhat LILO. Any necessary shifting of the 132kV Barishal-Bagherhat LILO circuits from the existing terminal tower to an adjacent tower is within the scope of this project.

(iii) Kachua- Matlab North 132kV double circuit line (Approx. 33km) using Single ACSR Grosbeak Conductor per phase, one 7x3.25 galvanized steel earthwire equivalent OPGW.

Approx. 1 km at each end of the line (total approx. 2km) shall be built on four circuit towers with two circuits strung to facilitate future line entry in the respective substations to minimize the right of way.

(iv) LILO of Chowmuhani-Ramganj 132kV double circuit transmission line at Chatkhil Substation (Approx. 2km) using Single ACSR Grosbeak Conductor per phase, two 7x3.25 galvanized steel earthwire equivalent OPGW. Dismantling and by-pass of existing Chowmuhani-Ramganj 132kV double circuit transmission line near LILO location.

(v) LILO of Shahjibazar – Brahmanbaria 132kV double circuit transmission line at Madhabpur Substation (Approx. 1.2km) using Single ACCC Grosbeak Conductor per phase, two 7x3.25 galvanized steel earthwire equivalent OPGW. Dismantling and by-pass of existing Shahjibazar – Brahmanbaria 132kV double circuit transmission line near LILO location.

(vi) LILO of Bogura(S)-Naogaon 132kV transmission line at Dupchanchia Substation (Approx. 2.5km) using Single ACCC Grosbeak Conductor per phase, two 7x3.25

galvanized steel earthwire equivalent OPGW. Dismantling and by-pass of existing Bogura(S)-Naogaon 132kV double circuit transmission line near LILO location.

(vii) LILO of Bheramara – Rajbari 132kV transmission line at Kumarkhali Substation (Approx. 0.6km) using Single ACCC Grosbeak Conductor per phase, two 7x3.25 galvanized steel earthwire equivalent OPGW. Dismantling and by-pass of existing Bheramara – Rajbari 132kV double circuit transmission line near LILO location.

(viii) Reconductoring of Shahjibazar-Brahmanbaria-Ashuganj 132kV transmission line (Approx. 52.4km double circuit and 10.9km four circuit) using Single ACCC Grosbeak Conductor per phase, one 7x3.25 galvanized steel earthwire equivalent OPGW at double circuit portion of the line and two 7x3.25 galvanized steel earthwire equivalent OPGW at four circuit portion of the transmission line.

2. The specification covers **following scope of works**:

a. Detailed survey including route alignment, profiling, tower spotting, optimization of tower locations, soil resistivity measurement & geotechnical investigation (including special foundation locations, viz. pile/well foundation locations, if any).

b. Check survey shall be conducted to locate tower locations on ground conforming to the approved profile and tower schedule.

c. The IEE (specifically the Environmental Management Plan) shall be followed by the contractor during the contract period to comply with environmental safeguards including social issues, Health & Safety. The contractor shall prepare & submit reports (e.g. Construction Environmental and Social Management Plan, Baseline Environmental Monitoring Report, Quarterly Environmental Monitoring Reports) according to the IEE (Environmental Management Plan) in due time after awarding the contract. The baseline environmental monitoring report and quarterly monitoring reports shall include laboratory (Govt. accredited/internationally recognized) based environmental parameters test reports by following Environmental Conservation Rules 2023 and IEE. A tree plantation plan shall be prepared by the contractor for undertaking 1:3 compensatory plantation with the timeline for completion prior to commissioning of substations and transmission lines. For tree plantation and Ecological Study, Quarterly Monitoring Report must be submitted up to the defect liability period. Monitoring and Reporting must be done for 2 years for tree plantation management status and viability assessment by the Contractor after the completion of the work.

d. Design, fabrication, testing and supply of all types of transmission line towers including stubs, fasteners, anti-theft fasteners, step bolts, hangers, D-shackles, number plate, danger plate, tower earthing etc.

Power Grid Bangladesh's existing design shall be used for all other towers to be used in the lines. The Employer shall provide structural/erection drawings, available shop drawings and available bill of materials of all types of transmission line towers and their extensions as required to the Contractor after placement of award, in sequence, suiting the project requirement upon written request of the Contractor. However, if the Contractor needs to prepare any additional structural and shop drawings or make any correction of existing drawings, these have to be prepared by

the Contractor without any additional cost. In such case, the Contractor has to submit relevant documents/drawings for approval of the Employer.

Bidders are requested to inspect the available drawings in Design Dept. of Power Grid Bangladesh to satisfy them regarding the extent of available drawings. Bidders are required to propose the tower materials from a manufacturer who will use the same material standard as mentioned in the tower drawings.

e. Fabrication, testing and supply of all types of tower accessories such as phase plates, circuit plates (wherever applicable), number plates, danger plates, anti-climbing devices, bird guards, ladders (wherever applicable), resting platforms (wherever applicable), etc.

f. Design, manufacture, testing and supply of conductors, insulators, OPGW, hardware fittings and conductor & OPGW accessories.

g. Design of foundations for different types of towers, testing of foundations and casting of foundations (including special foundation locations, viz. pile/well foundation locations, if any) for tower footings;

h. Erection of towers, tower earthing, fixing of insulator strings, stringing of conductors, OPGW along with all necessary line accessories,

i. Painting of towers & supply and erection of span markers, obstruction lights (wherever applicable) for aviation requirements (as required);

j. Stringing of conductors and earthwires. The entire stringing of conductors and earth wire shall be carried out by tension stringing technique. The Bidder shall indicate in their offer, the sets of tension stringing equipment he is having in his possession and the sets of stringing equipment he would deploy exclusively for the Contract execution, which under no circumstance shall be less than the number and capacity requirement indicated in Qualifying Requirements for Bidder.

k. Dismantling of existing Tower, Conductors, OPGW, EW with associated hardware fittings. The dismantled Conductors, OPGW, GW shall be re-rolled on metallic drums and handed over to Power Grid by the Contractor for auction. The dismantled Hardware Fittings shall be handed over to the relevant GMD offices in separate wooden boxes. The dismantled tower members shall be bundled and handed over to relevant GMD offices. The necessary transportation and any other works required shall be deemed to be included.

l. Testing & commissioning of the erected transmission lines and

m. Other items not specifically mentioned in this Specification and / or Schedule of prices but are required for the successful commissioning of the transmission line, unless specifically excluded in the Specification.

The Contractor is required to arrange any additional special arrangement/work which may require to complete the above works within the specified Completion Time but not expressly mentioned in the specification. The Contractor has to assess such scope and complete the works within the specified Completion Time within the Contract Price.

n. Major Contract Components:

i. Tower: 132kV double circuit and 132kV four circuit vertical formation lattice steel tower.

ii. Conductor:

Satkhira-Paikgacha 132kV double circuit transmission line: Single ACSR Grosbeak Conductor per phase.

Bhandaria-Mathbaria 132kV double circuit transmission line: Single ACSR Grosbeak Conductor per phase.

Kachua- Matlab North 132kV double circuit transmission line: Single ACSR Grosbeak Conductor per phase.

LILO of Chowmuhani-Ramganj 132kV double circuit transmission line at Chatkhil Substation: Single ACSR Grosbeak Conductor per phase.

LILO of Shahjibazar – Brahmanbaria 132kV double circuit transmission line at Madhabpur Substation: Single ACCC Grosbeak Conductor per phase.

LILO of Bogura(S)-Naogaon 132kV transmission line at Dupchanchia Substation: Single ACCC Grosbeak Conductor per phase.

LILO of Bheramara – Rajbari 132kV transmission line at Kumarkhali Substation: Single ACCC Grosbeak Conductor per phase.

Reconductoring of Shahjibazar-Brahmanbaria-Ashuganj double circuit 132kV transmission line: Single ACCC Grosbeak Conductor per phase.

iii. Earthwire and OPGW:
132kV: 7x3.25 galvanized steel earthwire and equivalent OPGW.

iv. Insulators & Hardware fittings

The scope of works has been described briefly in this section which may not covered all the works to be done under this Contract. Bidders are requested to go through carefully the complete bidding document to understand the detailed scope of works.

It may be mentioned here that, if the contract consists of multiple section/part/line then, in case of non-availability of a particular tower/item for a line section, the Contractor will be allowed to use that particular tower/item from another section without any change in the quoted rate.

Annex 1-2: Terminal Points

(i) Satkhira-Paikgacha 132kV double circuit transmission line:

Phase conductors and earthwires shall be terminated at the gantry structures of the substations.

OPGW termination boxes shall be installed at the base of the substations gantry structures.

A jumper of sufficient length shall be provided with the slack span to be terminated at the substation entry equipment.

The termination work of the jumper to the substation equipment is not scope of this contract.

(ii) Bhandaria-Mathbaria 132kV double circuit transmission line:

Phase conductors and earthwires shall be terminated at the gantry structures of the substations.

OPGW termination boxes shall be installed at the base of the substations gantry structures.

A jumper of sufficient length shall be provided with the slack span to be terminated at the substation entry equipment.

The termination work of the jumper to the substation equipment is not scope of this contract.

(iii) Kachua- Matlab North 132kV double circuit transmission line:

Phase conductors and earthwires shall be terminated at the gantry structures of the substations.

OPGW termination boxes shall be installed at the base of the substations gantry structures.

A jumper of sufficient length shall be provided with the slack span to be terminated at the substation entry equipment.

The termination work of the jumper to the substation equipment is not scope of this contract.

(iv) LILO of Chowmuhani-Ramganj 132kV double circuit transmission line at Chatkhil Substation:

Phase conductors and earthwires shall be terminated at the gantry structure of the substation at one end and at LILO points for other end.

OPGW termination boxes shall be installed at the base of the substation gantry structures for one end and at LILO point towers for other end.

A jumper of sufficient length shall be provided with the slack span to be terminated at the substation entry equipment.

The termination work of the jumper to the substation equipment is not scope of this contract.

(v) LILO of Shahjibazar – Brahmanbaria 132kV double circuit transmission line at Madhabpur Substation:

Phase conductors and earthwires shall be terminated at the gantry structure of the substation at one end and at LILO points for other end.

OPGW termination boxes shall be installed at the base of the substation gantry structures for one end and at LILO point towers for other end.

A jumper of sufficient length shall be provided with the slack span to be terminated at the substation entry equipment.

The termination work of the jumper to the substation equipment is not scope of this contract.

(vi) LILO of Bogura(S)-Naogaon 132kV transmission line at Dupchanchia Substation:

Phase conductors and earthwires shall be terminated at the gantry structure of the substation at one end and at LILO points for other end.

OPGW termination boxes shall be installed at the base of the substation gantry structures for one end and at LILO point towers for other end.

A jumper of sufficient length shall be provided with the slack span to be terminated at the substation entry equipment.

The termination work of the jumper to the substation equipment is not scope of this contract.

(vii) LILO of Bheramara – Rajbari 132kV transmission line at Kumarkhali Substation:

Phase conductors and earthwires shall be terminated at the gantry structure of the substation at one end and at LILO points for other end.

OPGW termination boxes shall be installed at the base of the substation gantry structures for one end and at LILO point towers for other end.

A jumper of sufficient length shall be provided with the slack span to be terminated at the substation entry equipment.

The termination work of the jumper to the substation equipment is not scope of this contract.

(viii) Reconductoring of Shahjibazar-Brahmanbaria-Ashuganj double circuit 132kV transmission line:

Phase conductors and earthwires shall be terminated at the 132kV bus of the AIS substations or GIL Bushing (SF6 to Air Bushing) or Outdoor Cable Sealing End of the GIS substations.

OPGW termination boxes shall be installed at the base of the substations' gantry structures.

A jumper of sufficient length shall be provided with the slack span to be terminated at the substation entry equipment.

The termination work of the jumper to the substation equipment is in the scope of this contract.

TECHNICAL SPECIFICATIONS

2. Site Particulars

2.1 General

The location of the transmission line(s) and associated climatic conditions described in the following clauses are given for guidance only.

2.2 Location

For details of the location of the transmission line(s) reference should be made to associated drawings included with the specification.

2.3 Climatic Conditions

For details of the climatic conditions associated with the site, please refer to **Annex 2-1**. The Contractor is advised to make a thorough study of local climatological records, since no delays to the completion date due to adverse weather conditions shall be accepted.

Annex 2-1: Climatic Conditions

The climatic conditions associated with the site are summarised below. However, the Contractor is advised to make a thorough study of local climatological records, since no delays to the completion dates due to adverse weather conditions shall be accepted.

All plant and equipment supplied under the contract shall be entirely suitable for the climatic conditions prevailing at site.

The project area and vicinity is close to sea level and is in a tropical climate. The ambient shade temperature variation is between 4 °C and 45 °C with periods of high humidity.

Between May and November, low-lying areas are subject to flooding. Flooding countermeasure shall be taken for the civil design, so as not to affect any equipment or works during the wet season. As per the recorded past maximum flood water levels in the project area, sufficient ground level height for land formation is required at the Contractor's responsibility. On certain sites, the flooding can be taken as an advantage in that the heavy loads may be floated on barges to close proximity of the sites.

The project area is a designated zone of moderate earthquake intensity. The seismic factor is 0.1 g.

Atmospheric pollution is moderate and no special insulator design or washing is required. The area is subject to high winds of typhoon strength.

Description	**Unit**	**Required**
Maximum ambient shade temperature	°C	45
Minimum ambient shade temperature	°C	4
Maximum daily average temperature	°C	35
Every Day Temperature for design (EDT)	°C	30
Maximum annual average temperature	°C	25
Maximum wind velocity for line design purposes (3s Gust Wind Speed)		
(i) Satkhira-Paikgacha 132kV D/C TL	m/s	68.1
(ii) Bhandaria-Mathbaria 132kV D/C TL	m/s	80
(iii) Kachua- Matlab North 132kV D/C TL	m/s	50.6
(iv) LILO of Chowmuhani-Ramganj 132kV D/C TL at Chatkhil Substation	m/s	56.7
(v) LILO of Shahjibazar – Brahmanbaria 132kV D/C TL at Madhabpur Substation	m/s	56.7
(vi) LILO of Bogura(S)-Naogaon 132kV D/C TL at Dupchanchia Substation	m/s	61.9
(vii) LILO of Bheramara – Rajbari 132kV D/C TL at Kumarkhali Substation	m/s	66.9
(viii) Reconductoring of Shahjibazar-Brahmanbaria-Ashuganj 132kV TL	m/s	56.7
Minimum wind velocity for line rating purposes	km/h	3.2
Solar radiation	W/m²	1000
Rainfall	mm/year	2500
Relative humidity, maximum	%	100
Relative humidity, average	%	80
Altitude	m	< 1000
Atmospheric pollution	-	medium
Icing		no ice or snow

Description	Unit	Required
		expected
Seismic factor	g	0.1
Soil type	-	alluvial
Soil temperature (at 1.1 m)	°C	30 °C at 1.1 meter depth
Soil thermal resistivity	°Cm/W	1.5
Isokeraunic level (thunderstorm days/year)	days/year	80

The information in this clause is given solely for the general assistance of Bidders and no responsibility for it will be accepted nor will any claim based on this clause be considered.

3. Quality Assurance

3.1 General

3.1.1 The quality assurance arrangements shall conform to the appropriate sections of BS EN ISO 9001.

3.1.2 The Contractor's / Supplier's quality programme for the works shall define the systems and procedures adopted to ensure compliance with the contract requirements. These systems shall include the following:

Hold Point: "A stage in the implementation of project works including material procurement or fabrication/workmanship process beyond which work shall not proceed without the documented approval of the Engineer or their appointed representatives".

Notification Point: "A stage in the implementation of project works including material procurement or fabrication/workmanship process for which advance notice of the activity is required to permit attendance".

3.1.3 The Contractor/Supplier is required to give the Engineer or their appointed representatives the requisite period of notice of any notification point for which attendance is required.

3.2 Quality Assurance Program

3.2.1 The quality assurance programme shall give a description of the quality system for the works and shall include the following details:

a. The structure of the Contractor's/Supplier's organization
b. The duties and responsibilities of staff assigned to ensure quality of the work
c. The system for purchasing, taking delivery and verification of materials
d. The system for ensuring quality of workmanship
e. The system for control of documentation
f. The system for retention of records
g. The arrangements for the Contractor's/Suppliers auditing
h. A list of the administrative and work procedures required to achieve and verify the contract's Quality requirements. These procedures shall be made readily available to the Engineer for inspection on request.

3.2.2 The quality assurance programme for the works shall be submitted to the Engineer for approval within 30 (thirty) days of signing of contract; unless the Contractor's/Supplier's quality system has been previously audited and approved by the Engineer on behalf of the Employer/Purchaser. **This is a Hold Point.**

3.3 Quality Plan

A specific quality plan for each section of the work shall be produced by the Contractor and/or Supplier. Each quality plan shall set out the activities in a logical sequence and shall take into account the following:

a. An outline of the proposed work and programme sequence
b. The structure of the Contractor's and/or Supplier's organisation for the contract
c. The duties and responsibilities of staff assigned to ensure quality of work for the contract
d. Hold and notification points
e. Submission of Engineering documents required by this specification
f. The inspection of materials and components on receipt
g. Reference to the Contractor's and/or Supplier's quality assurance procedures appropriate to each activity
h. Inspection during fabrication/construction
i. Final inspection and tests.

The Contractor's and/or Supplier's quality plan shall be submitted to the Engineer for approval within 30 (thirty) days of signing of contract. **This is a Hold Point.**

Notification and hold points are given in **Annex 3-1**.

3.4 Equivalent Standards

3.4.1 The IEC and BSI standards, together with other references referred to in this specification are listed in **Annex 3-2**. It is the Contractor's / Supplier's responsibility to ensure they are in possession of the latest edition, including all amendments current on the defined date prior to the bid closing date.

3.4.2 Materials or equipment conforming to alternative international or national standards will be considered by the Engineer, provided that these standards ensure an equivalent or higher quality.

3.4.3 The Contractor/Supplier shall bring to the attention of the Engineer any inconsistencies between the requirements of these Standards and this specification.

3.4.4 Where equivalent standard(s) are offered as an alternative, the Contractor/Supplier shall provide two copies of English language translations of the standard(s) at no extra cost to the contract.

3.5 Quality Control

3.5.1 Inspection and Testing

The prime responsibility for inspection and testing rests with Contractor/Supplier. The inspection and acceptance of drawings, materials and workmanship; or the waiver of inspection by the Engineer does not relieve the Contractor/Supplier of any obligations or responsibilities to carry out the work in accordance with the contract. The inspection and testing shall be documented in such a way that it is possible to verify that it was undertaken. Records of inspection shall include as a minimum the contract

identity, the name of inspector/tester, date of inspection/test, operation/inspection, technique used, acceptance standards, criteria and acceptability.

3.5.2 Type, Sample and Routine Tests

Type, sample and routine tests shall be undertaken as appropriate on all components supplied and/or installed under this contract, in accordance with the requirements of this specification.

3.5.3 Certificate of Conformity

Prior to the issue of the "Release Certificate" or agreement to shipping, the Contractor/Supplier shall submit to the Engineer 3 (three) copies of the completed certificate of conformity (see **Annex 3-3**). The certificate shall be supported by copies of the appropriate material test certificates, inspection records, type and sample test reports as detailed in the relevant section of this specification.

The documents to be submitted by the Contractor are listed in **Annex 3-4**.

3.6 Non-Conforming Products

The Engineer shall review the non-conforming products in accordance with BS EN ISO 9001.

3.7 Monitoring of Quality Assurance Arrangements

Monitoring of quality assurance arrangements may be undertaken by the Engineer/Employer during the course of the contract. This will take the form of surveillance of the activities at work locations and/or by formal audits of the Contractor's/Suppliers systems and procedures that constitute his quality assurance arrangements. Corrective actions shall be agreed and implemented in respect of any deficiencies.

The Contractor/Supplier (including his suppliers or Subcontractors) shall provide all facilities including access, which may be required by the Engineer/Employer for monitoring activities.

3.8 Suppliers and Subcontractors

The Contractor/Supplier shall ensure that any suppliers or Subcontractors appointed by him under the contract shall conform to the requirements of this specification. Prior to the appointment of any Supplier/Subcontractor the Contractor/Supplier shall ensure that their quality assurance arrangements comply with the requirements of BS EN ISO 9001 and this specification.

The Contractor's auditing of his Supplier's/Subcontractor's quality assurance arrangements shall be documented to demonstrate to the Engineer their extent and effectiveness.

3.9 Method Statements

Prior to commencing any section of the work, the Contractor shall submit method statements in accordance with the requirement of the relevant section of this specification. Submission of these method statements shall be treated as **Hold Points**.

When requested by the Engineer or their appointed representatives, additional method statements related to specific items of work shall be provided by the Contractor.

Annex 3-1: Notification and Hold Points

Clause Reference	Document Description	Comment
3.2		Quality Assurance Programme
3.3		Quality Plan

Annex 3-2: Reference Standards

The reference standards and other documents referred to in this chapter of the specification are listed below:

BS EN ISO 9001 - Model for quality assurance in design, development, production, installation and servicing.

Annex 3-3: Certificate of Conformity

Certificate of Conformity

To: Project Director
Power Grid Company of Bangladesh Ltd.
IEB Bhaban
Ramna, Dhaka-1000, Bangladesh

From: (Contractor's Details)

Contract: _____

We certify that the products detailed below have been inspected, tested and unless noted to the contrary, conforming all respects to the requirements.

Quantity	Description	Attachments	Please tick
		Test reports (details) Other (as per relevant sections)	☐ ☐
		Test reports (details) Other (as per relevant sections)	☐ ☐
		Test reports (details) Other (as per relevant sections)	☐ ☐

Date and signature: _____

Annex 3-4: Engineering Documents to be submitted by the Contractor

Clause Reference	Documents Description	Comment
3.2	Quality Assurance Programme	
3.3	Quality Plan	
3.4	Equivalent standards	if applicable

Annex 3-5: Field Quality Plan for Transmission Lines

Standard Field Quality Plan for Transmission Lines - Document No. Power Grid Bangladesh/FQP/TL/001, Rev. 00

No.	Description of Activity	Items to be Checked	Tests / Checks to be done	Ref. Documents	Check/Testing		Counter Check / Test by Employer	Accepting Authority in Employer
					Agency	Extent		
1.	**Detailed Survey**	a. Route alignment	Optimization of route length	a. Preliminary survey b. Topographical map c. Tower spotting data given by Engineer	Contractor	100% at Field	100% based on record documents	Project in charge
		b. Route profiling & tower spotting.	1. Ground clearance 2. Wt. span 3. Sum of adj. span (wind span) 4. Angle of deviation	a. Sag template b. Tower spotting data c. Route alignment	Contractor	100% at Field	100% based on record documents	Line in charge
2.	**Check Survey**	Tower location & final length	1. Alignment 2. Final length	a. Route alignment b. Tower schedule c. Profile	Contractor -do-	100% at Field -do-	i) All angle towers in plains and 50% in hilly terrains. ii) Final length to be checked on 100% basis based on records /documents	Section In charge
3.	**Detailed Soil Investigation**	a. Bore log	1. Depth of bore log 2. SPT 3. Collection of samples	As per Employer's Specification	Contractor	100% at Field	To witness 40% at field	Section in charge
		b. Tests on samples	As per tech. Specs.	As per Employer's Specification	Lab approved by Employer	100% by testing lab	Review of lab test results	Line in charge based on the report review by site engineer.

No.	Description of Activity	Items to be Checked	Tests / Checks to be done	Ref. Documents	Check/Testing		Counter Check / Test by Employer	Accepting Authority in Employer
					Agency	Extent		
4.	**Tower Foundation**	**A. Materials** 1. Cement	1. Source approval	Source meeting Employer's Specification /approved vendor	Contractor	As proposed by Contractor	To verify the proposal based on the supply made and factory test results.	Line in charge
			2. Physical tests	As per Annex 3-6	Samples to be taken jointly with Employer and tested at Employer approved lab	Review of all MTC's and one sample for every 500 MT	100% review of lab test results	Line in charge
			3. Chemical Tests Chemical composition of Cement	-do-	Contractor to submit MTC	100% review of MTC by Contractor	100% review of MTC	Line in charge
		2. Reinforcement Steel	1. Source approval	To be procured from main producers only.	Contractor	As proposed by Contractor	To review the proposal based on the documents.	Line in charge.
			2. Physical and chemical analysis test	As per Annex 3-6	Contractor to submit MTC	All MTCs	100% review of MTC	Line in charge
		3. Coarse Aggregates	1. Source approval	Source meeting Employer Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the test results of Joint samples tested in Employer approved lab	To review the proposal based on the documents	Line in charge
			2. Physical tests	As per Annex 3-6	Samples to be taken jointly and tested in Employer-approved lab	One sample per lot of 200 cum or part thereof	100% review of lab test results	Line in charge

No.	Description of Activity	Items to be Checked	Tests / Checks to be done	Ref. Documents	Check/Testing		Counter Check / Test by Employer	Accepting Authority in Employer
					Agency	Extent		
		4. Fine aggregate	1. Source approval	Source meeting Employer Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the results of Joint samples tested in Employer approved lab.	To review the proposal based on the documents.	Line in charge
			2. Physical test	As per Annex 3-6	Samples to be taken jointly and tested in Employer approved lab	One sample per lot of 200 cum or part thereof	100% review of lab test results	Line in charge
		5. Water	1.Cleanness (Water shall be fresh and clean)	Employer's Specification	Contractor	100% visual check at Field	Verification at random	Site Engineer
			2. Suitability of water for concreting	Employer's Specification	Contractor	100%Visual Check at Field	Verification at random	Site Engineer
		B. Classification	1. Visual observation of soilstrata 2. Groundwater level 3. History of water table in adj. area/surface water 4. Soil Investigation wherever required	Employer's Specification	Contractor	100% at Field	100% at Field	a. Section in charge b. In case of WBC/SFR /FS acceptance by line in charge c. For Spl. foundations /pile foundations acceptance by Project Engineer in charge

No.	Description of Activity	Items to be Checked	Tests / Checks to be done	Ref. Documents	Check/Testing		Counter Check / Test by Employer	Accepting Authority in Employer
					Agency	Extent		
		C. Concrete Works a. Before concreting						
		1. Bottom of excavated earth	Depth of foundation	Approved drawings	Contractor	100% at field	100% check by Employer	Site Engineer
		2. Stub setting	1) Centre Line 2) Diagonals 3) Level of stubs	-do-	-do-	-do-	-do-	-do-
		3. Reinforce-ment steel	Placement	Bar bending schedule	-do-	-do-	-do-	-do-
		b. During concreting						
		1. Workability	Slump test	Range 50 mm to100 mm refer document at Annex 3-6(5)	Contractor	100%atfield	40% check at random	Site Engineer
		2. Concrete strength	Cubes comp strength	PWD SPEC as referred in document at Annex 3-6(5)	Casting of cubes at site. Cubes to be tested at Employer-approved lab for 28days strength	One sample of 4 cubes in each tower locations or per 6 cum concreting per day work	100% review of lab test results.Cubesat40% location are to be taken in presence of Employer's officials	Section in charge

No.	Description of Activity	Items to be Checked	Tests / Checks to be done	Ref. Documents	Check/Testing		Counter Check / Test by Employer	Accepting Authority in Employer
					Agency	Extent		
5.	**Pile foundations**	1. All materials like cement, steel, coarse / fine aggregate, water	To be tested as per procedure enumerated in the respective columns above					
		2. Before concreting	1. Check for centre line of each pile	Approved Drawings	Contractor	100%	100%	Site Engr.
			2. Check for diameter /verticality of each pile	-do-	-do-	-do-	-do-	-do-
			3. Check for depth of each pile	-do-	-do-	-do-	-do-	-do-
		3. During concreting						
		a. Workability	1. Slump test	150-200mm as per Employer's Specif.	Contractor	For each leg	100% at field	Site ENGINEER
		b. Concrete strength	2. Cubes compressive strength	As per Employer's specifications	Contractor. One set of cubes (min. 4 pieces) to be taken and tested for 7 & 28 days strength at Employer-app-roved laboratory	For pile one set for each leg. For pile caps, beams, chimney, one sample for every 6 m^3 or part thereof for each day of concreting.	100% cubes for piles, 20% pile caps, beams, chimney etc. to be taken in presence of Employer's officials. 100% review of test results.	Section in charge.
6.	**Tower Erection**	1. Materials a. Tower member / bolts & nuts / washers / accessories	Visual checking for 1. Stacking 2. Cleanliness 3. Galvanizing 4. Damages	Approved drawings /BOM	Contractor	100% at stores	100% verification of records	Site Engineer

No.	Description of Activity	Items to be Checked	Tests / Checks to be done	Ref. Documents	Check/Testing		Counter Check / Test by Employer	Accepting Authority in Employer
					Agency	Extent		
		2. Erection of super-structure	1. Sequence of erection	As per approved drawings /Employer's specifications	Contractor	100% at field	100% check	Site Engineer
			2. Check for completeness	-do-	-do-	-do-	-do-	-do-
			3. Tightening of nuts and bolts	-do-	-do-	-do-	-do-	-do-
			4. Check for verticality	-do-	-do-	-do-	-do-	-do-
			5. Tack welding for bolts & nuts	Employer's Specifications	Contractor	100%at field	100%check	Site Engineer
		3. Tower footing resistance(TFR)	TFR at locations before and after earthing.	Employer's Specifications	Contractor	100%at field	20%locationstobe verified	Line in charge
7.	**Stringing**	1. Materials						
		a. Insulators	1. Visual check for cleanliness/glazing / cracks/white spots.	Employer's Specifications	Contractor	100% at Field	100% verification of records and to carry random checks 10%	Site Engineer
			2. IR Value	(min. 50MOhms)	-do-	One test per sample size of 20 for every lot of 10,000	To verify Contractor's records 100% and joint check 20% of total tests	-do-
			3. E&M test	-	Insulator supplier	a. 20 per 10,000 for discs b. 3 per 1500 for long rod	Collection of samples, sealing them and handing over by Employer to insulator supplier	Tests to be witnessed / Approved by QA & I at Manufacturer's works

No.	Description of Activity	Items to be Checked	Tests / Checks to be done	Ref. Documents	Check/Testing		Counter Check / Test by Employer	Accepting Authority in Employer
					Agency	Extent		
			4. Traceability (make/batch no./locations where installed)	Packing list/CIP	Contractor	100% at field	100% Review of records	Site Engineer
		b. Conductor	On receipt, 1. Visual check of drum.	Packing list	Contractor	100% at stores	20% check	Site Engineer
			2. Check for seals at both ends, and Employer's sticker on outer end	-do-	-do-	-do-	-do-	-do-
			3. Check depth from top of flange to the top of the outer most layer	-do-	-do-	-do-	-do-	-do-
		c. Earthwire	Check for seals at both ends	Packing list	Contractor	100% at stores	20% check	-do-
		2. Field activity						
		a. Before stringing	Readiness for stringing	Stringing procedures as per approved specifications	Contractor	Readiness certificate to be submitted by the Contractor	Review of Certificate	Line in charge
		b. During stringing	(Conductor / earthwire)					
			1. Scratch/cut check (visual)	Approved drawings/ Employer's specifications	Contractor	100% at Field	100% record & field check 20%	Site Engineer
			2. Repair sleeve	-do-	-do-	-do-	-do-	-do-
			3. Mid span Joints	-do-	-do-	-do-	-do-	-do-
			4. Guying (in case of towers not	Approved guying arrangement /	-do-	-do-	100%	Section in charge

No.	Description of Activity	Items to be Checked	Tests / Checks to be done	Ref. Documents	Check/Testing		Counter Check / Test by Employer	Accepting Authority in Employer
					Agency	Extent		
			designed for one side stringing)	Employer's specifications				
		c. After stringing	Check for					
			1. Sag/Tension	Sag tension chart/tower spotting data	-do-	-do-	100% record & field check 20%	Site Engineer
			2. Electrical clearances	As per approved drawings / Employer's specifications	-do-	-do-	-do-	-do-
			i) Ground clearance	-do-	-do-	-do-	-do-	-do-
			ii) Live metal clearance etc.	-do-	-do-	-do-	-do-	-do-
			3. Jumpering	-do-	-do-	-do-	-do-	-do-
			4. Placement of spacer/damper	As per specification / drawings / placement chart	-do-	-do-	-do-	-do-
8.	**Final Testing**							
	a. Pre-commissioning of lines	a. Readiness of lines for pre-commissioning	1. Completeness of line. 2. Meggar test of line	As per approved drawings / Employer's latest pre-commissioning procedures	Contractor	100%	100% joint checking	Project in charge

No.	Description of Activity	Items to be Checked	Tests / Checks to be done	Ref. Documents	Check/Testing		Counter Check / Test by Employer	Accepting Authority in Employer
					Agency	Extent		
	b. Commis-sioning of line	Readiness of lines for commissioning	2. Digital photograph of each tower to ascertain the completeness of tower.	a. Employer's latest pre-commissioning procedures b. Pre-commissioning report c. CEA clearance	-do-	-do-	-do-	-do-
			3. Electrical Inspectors clearance from CEA		-do-	-do-	-do-	-do-

Annex 3-6: Acceptance Criteria and Permissible Limits

Annex 3-6(1): Acceptance Criteria and Permissible Limits for Cement

1. Mechanical and physical requirements given as characteristic values

Strength Class*	Early Strength		Standard Strength	Initial Setting Time (min.)	Soundness (mm)
	2days	7days	28days		
32.5N	-	≥ 16.0	≥ 32.5	≥ 75.0	≤ 10.0
32.5R	≥ 10.0	-			
42.5N	≥ 10.0	-	≥ 42.5	≥ 60.0	
42.5R	≥ 20.0	-			
52.5N	≥ 20.0	-	≥ 52.5	≥ 45.0	
52.5R	≥ 30.0	-			

2. Chemical requirements given as characteristic values

Property	Test Reference	Cement Type	Strength Class*	Requirements
Loss on ignition	EN 196-2	CEM I CEM III	All	≤5.0%
Insoluble residue	EN 196-2	CEM I CEM III	All	≤5.0%
Sulphate content (as SO_3)	EN 196-2	CEM I CEM II CEM IV CEM V	32.5N 32.5R 42.5N	≤3.5%
			42.5R 52.5N 52.5R	≤4.0%
		CEM III	All	
Chloride content	EN 196-21	All	All	≤0.1%
Pozzolanicity	EN 196-5	CEM IV	All	Satisfies the test

* A class with ordinary early strength, indicated by N and a class with high early strength indicated by R.

* **The requirements are not limited to, those mentioned above. For details of the requirements shall be made to the BDS EN 197-1.**

Annex 3-6(2): Acceptance Criteria and Permissible Limits for Reinforcement Steel

No.	Name of the Test	Carbon Steel Bars as per BS 4449		Remarks
		Grade 250	Grade 460	
i)	Chemical analysis test			
	Carbon	0.25% max.	0.25% max.	
	Sulphur	0.06% max.	0.05% max.	
	Phosphorus	0.06% max.	0.05% max.	
ii)	Physical tests			
	Specified characteristic strength	250 N/mm³	460 N/mm³	Testing in approved lab
	Minimum elongation	22%	12%	Testing in approved lab
iii)	Bend & re-bend tests	Pass	Pass	Testing in approved lab

The requirements are not limited to those mentioned above. For details of the requirements, refer to BS4449.

Annex 3-6(3): Acceptance Criteria and Permissible Limits for Coarse Aggregate

3.	Coarse Aggregates - Physical Tests									
	a. Determination of particles size	a. Sieve Designation	Percentage passing for Single-Sized Aggregate of Nominal Size					Percentage Passing for Grades Aggregate of Nominal Size			
			40mm	20mm	16mm	12.5mm	10mm	40mm	20mm	16mm	12.5mm
		63mm	100	-	-	-	-	-	-	-	-
		40mm	85-100	100	-	-	-	95-100	100	-	-
		20mm	0-20	85-100	100	-	-	30-70	95-100	100	100
		16mm	-	-	85-100	100	-	-	-	90-100	-
		12.5mm	-	-	-	85-100	100	-	-	-	90-100
		10mm	0-5	0-20	0-30	0-45	85-100	10-35	25-35	30-70	40-85
		4.75mm	-	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
		2.36mm	-	-	-	-	0-5	-	-	-	-
	b. Flakiness index		Not to exceed 25%								
	c. Crushing value		Not to exceed 45%								
	d. Presence of deleterious material		Total presence of deleterious materials not to exceed 5%								
	e. Soundness test (for concrete work subject to frost action)		12% when tested with sodium sulphate and 18% when tested with magnesium sulphate								

Annex 3-6(4): Acceptance Criteria and Permissible Limits for Fine Aggregate

4	Fine aggregates - Physical Tests	Sieve Designation	Percentage Passing for Graded Aggregate of Nominal Size		
			F.A. Type I	F.A. Type II	F.A. Type III
	a) Determination of particle size	10 mm	100	100	100
		4.75 mm	90-100	90-100	90-100
		2.36 mm	60-95	75-100	85-100
		1.18 mm	30-70	55-90	75-100
		600 microns12.5 mm	15-34	35-59	60-79
		300 microns	5-20	8-30	12-40
		150 microns	0-10	0-10	0-10
	b) Silt content		Not to exceed 8%	Not to exceed 8%	Not to exceed 8%
	c) Presence of deleterious material	Total presence of deleterious materials shall not exceed 5%			
	d) Soundness Applicable to concrete work subject to frost action	12% when tested with sodium sulphate and 15% when tested with magnesium sulphate			

Annex 3-6(5): Acceptance Criteria and Permissible Limits for Concrete Work

1)	Concrete	a) Workability	Slump shall be recorded by slump cone method and it shall between 50-100 mm for pile cap and chimney, 150mm to 200mm for concrete pile.
		b) Compressive strength	For pile one set for each leg. For Pile caps, beams, Chimney, one set for every 6 Cu.m. or part thereof for each day of concreting. Each set consists of four cubes, one for 7 days testing and two for 28 days testing shall be taken.

Notes - Acceptance Criteria are based on 28 days compressive strengths for nominal mix concrete:

a. The average of the strength of three specimen be accepted as the compressive strength of the concrete, provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.

b. If the actual average strength of accepted sample exceeds specified strength by more than 30%, the Engineer-in-charge, if he so desires, may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of the specified strength, it will be restricted to 30% only for computation of strength.

c. If the actual average strength of accepted sample is equal to or higher than specified up to 30%, the strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.

d. If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate at the discretion of Engineer-in-charge.

e. If the actual average strength of accepted sample is less than 70% of specified strength, the Engineer-in-charge shall reject the defective portion of work represent by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall take at the risk and cost of Contractor. If, however, the Engineer-in-charge so desires, he may order additional tests to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the Contractor.

General Notes:

- This standard Field Quality Plan is not to limit the supervisory checks that are otherwise required to be carried out during execution of work as per drawings/Technical specifications etc.
- Contractor shall be responsible for implementing/documenting the quality plan. Documents shall be handed over by the Contractor to Employer after the completion of the work.
- Project in charge means over all in charge of work. Line In charge means in charge of the line. Section in-charge means in charge of the section.
- Acceptance criteria and permissible limits for tests are indicated in the Annexure. However for further details/tests Employer
- specification and relevant standards shall be referred.
- Tests as mentioned in this FQP shall generally be followed. However Employer reserves the right to order additional tests wherever required necessary at the cost of the Contractor.

Annex 3-7: Approximate Positions of Towers

Approximate positions of the angle and terminal towers and the positions of such intermediate towers as it may have been desirable to determine during preliminary way leave negotiations are indicated on Reference data given in this specification.

The conceptual drawings for line elements are indicated in this specification.

4. Design Particulars

4.1 Philosophy of Design

4.1.1. The philosophy of design in this specification is based upon deterministic principles, whereby the applied loading multiplied by the appropriate safety factor must be less than the ultimate strength of the component.

4.1.2. In bidding the Contractor/Supplier will be deemed to have concurred, as an experienced Manufacturer, with the design and layout of the works as being sufficient to ensure reliability and safety in operation, freedom from undue stresses and satisfactory performance in all other essentials as a working plant.

4.1.3. The transmission line(s) shall be designed with high reliability and low cost maintenance as the primary consideration in accordance with the relevant sections of the Specification.

4.1.4. The design shall incorporate all reasonable precautions and provisions for the safety of those concerned in the erection and subsequent maintenance of the contract works.

4.2 Units of Measurement

In all correspondence, technical schedules, design calculations and drawings, the metric (SI) units of measurement shall be used. Angular measurement shall be degrees, with 90° comprising a right angle.

4.3 Document Submission

The Contractor/Supplier shall submit to the Engineer all design calculation drawings, method statements, test programmes, test records etc. as defined in the different chapters of the specifications, or as otherwise agreed by the Engineer. For details of the number of copies and time periods for approval, reference should be made to **Annex 4-1**.

4.4 Design Calculations

4.4.1 All sets of calculations shall be complete, bound, properly titled and given a unique drawing number (see clause 4.5.1). The binding shall be such as to allow the easy introduction of subsequent pages if necessary.

4.4.2 Bound into each set shall be a fully detailed index. Following this shall be a design information sheet(s) which shall incorporate the following details:

a. The design concept shall be summarised;
b. Full details of manuals, design papers or other aids referred to in the text shall be given, with photocopies of relevant sheets if appropriate;
c. Full loading shall be reiterated, with their derivation if appropriate;
d. Design stresses shall be reiterated;
e. Code or standard references should be quoted, and equations written out in full for initial calculations;

4.4.3 Should the Contractor/Supplier be required to re-submit amended calculation or additional sheet(s), the following annotation shall be adopted:

- Amended sheets should retain the same sheet number, but have a lower case revision letter suffix i.e. sheet 14 when amended becomes 14a, then 14b.
- Additional sheets that needed to be inserted shall be given the sheet number they are added to, plus an upper case letter prefix i.e. additional sheets to piece 60 become A60, B60 etc. and if subsequently amended A60a etc.

4.4.4 Where computer programs are used for design calculations, a full explanation in English language shall be provided to assist the Engineer's approval of the calculations for each and every program used. Details must include name of program, author, source, comprehensive description of theoretical basis including all references to relevant documentation, checks undertaken on program and a list of projects on which the program has been used.

4.5 Drawings

4.5.1 General Requirements

4.5.1.1. Drawings shall be to scale, fully detailed and all dimensions shall be in metric units. General arrangement drawings submitted shall be to a scale of not less than 1 to 50 and all detailed drawings not less than 1 to 20. Profile drawings shall normally be drawn to vertical scale of 1 to 200 and a horizontal scale of 1 to 2,000.

4.5.1.2. Drawings sheets shall conform in size to BS ISO 5457, mainly A0, A1, A2, A3 and A4. The sheet size is to be stated on the drawing within or adjacent to the title block. Drawings shall be to BS 308 or equivalent.

4.5.1.3. The scale used shall be stated on the drawing as a ratio together with a linear scale at a convenient position along the margin of the original drawing sheet.

4.5.1.4. The physical drafting requirements in respect of line density, strength, contrast, spacing and character liability shall be met to ensure drawings are suitable for copying.

4.5.1.5. All drawings shall bear English title, serial number of the main contract, drawing number unique to this contract and scale. The system of numbering and layout of the title block will be to the approval of the Employer. The title block shall include the name and address of the Employer. The revision notes shall detail the nature of each revision. The revision shall be enclosed in a cloud with the revision letter indicated.

4.5.2 Computer Generated Drawings/Designs

All drawings shall be prepared using AutoCAD software version 2007or later only. Drawings, which are not compatible to AutoCAD software version 2007 or later shall not be accepted. After final approval all the drawings (structural drawings, BOMs, shop sketches and tower accessories, hardware fittings, plan & profile, sag curve, etc. drawings) shall be submitted to the Employer on CDs.

In addition to the hardcopy of drawings/designs the contract is required to submit soft copy of all the drawings in AutoCAD format and all related documents in Microsoft Word/Excel format. For drawings /designs developed by PLS software, the soft copy of the input files and other related files are also required to be submitted during submission of hardcopy for approval.

4.5.3 Contract Drawing List

At defined intervals the Contractor/Supplier shall submit the required number of copies of the contract drawing list.

The list shall contain the following information:

a. Drawing number;
b. Drawing title;
c. Revision status;
d. Submission date.
e. Date of receipt of comments/approval.
f. Approval status.

All changes since the previous issue shall be clearly indicated and when agreed only the front (index) sheet and revised sheets need to be submitted.

4.5.4 Contract Record Drawings

The Contractor/Supplier shall submit to the Engineer:

a. A final issue of the contract drawing list indicating which of the drawings, design calculations, method statements etc. he proposes to issue as final contract drawings. These drawings shall be updated to incorporate all modifications made during erection and commissioning
b. Requisite number of prints of each schedule, including where appropriate the supply and installation material manual
c. Requisite number of drawings, including design calculations, schedules including the supply and Installation Material Manual on CD-ROM in WPG /DXF /PDF /DWG /DOC format. The tower drawings and plan & profile drawings shall be submitted in AutoCAD format.

The distribution of the contract record drawings will be advised by the Engineer.

4.5.5 Route Maps

4.5.5.1 During the progress of the work the Contractor shall record on profiles, tower and Installation Material Manual (SIMMs) and on a set of survey maps of approved scale such particulars as will allow an accurate reference to be made afterwards in case of any faults or projected modifications to the line.

4.5.5.2 The map and/or profile sheet shall show the exact position of every tower with approved reference marks. The maps shall be supplemented, or profiles marked by sketches where necessary, to delineate boundary positions of towers which cannot be clearly indicated on the maps.

4.5.5.3 The data included on the maps, profile, sketches and SIMMs shall be submitted to the Engineer, to whom facilities shall be given for examining such records during the progress of the work.

4.6 Sag Templates (not used)

4.7 Supply and Installation Material Manual (SIMM)

As soon as final support positions are selected and approved, the Contractor shall provide the requisite copies of the A4 size Supply and Installation Material Manual (SIMM).

Each tower position shall be represented by one sheet of the, manual with the following information recorded:

a. Provisional and final tower numbers;
b. Profile and Record Map reference drawing numbers;
c. Span;
d. Wind span;
e. Weight span;
f. Angle of deviation;
g. Tower type, leg and body extensions and general arrangement (G.A.) drawing reference numbers;
h. Foundation type and G.A. drawing reference number;
i. Earthing details and G.A. drawing reference number;
j. Insulator set details and G.A. drawing reference number;
k. Sag adjustment setting, and linkage requirements where appropriate;
l. Phase conductor jumper details including spacer and general arrangement drawing reference number where appropriate;
m. Earthwire set details and G.A. drawing reference number;
n. Earthwire vibration damper G.A. drawing reference number;
o. Aircraft navigation (obstruction aids) drawing reference number where appropriate;
p. Fibre optic junction boxes and cabling G.A. drawing reference number where appropriate;

In addition the following schedules shall be included:

- Phase conductor and earthwire sags and tensions (erection and final);
- Suspension insulator set off-sets;
- Location and spacing of phase conductor spacers and spacer dampers (where appropriate);

- Location of all phase conductor and earthwire tension and non-tension joints;
- Location and spacing of all aircraft warning spheres (where appropriate);
- Location of all fibre optic joint boxes - (where appropriate).

The appropriate reference drawing numbers shall also be included. Preliminary copies of SIMMs shall be available prior to any site work commencing, together with material summaries. **This is a Hold Point.**

4.8 Maintenance Manual

4.8.1 The Contractor/Supplier shall provide to the Engineer at the specified period before the end of the construction period of the contract, a maintenance manual covering the following information:

a. Type, code number and description of all plant erected, together with names and addresses of manufacturer;
b. Methods of assembly of all fittings;
c. Method of replacing any part of the plant including the use of maintenance holes provided on the support, access provisions and where appropriate the application of 'live-line' maintenance techniques;
d. Recommendations of preventive maintenance including frequency of inspections;
e. List of recommend maintenance equipment with a description of its use and limitations;
f. Type and application of temporary earthing equipment;
g. Personnel safety equipment requirements and any risk assessments required.

4.8.2 The above information must be as specified in this contract and entirely in the English language.

4.8.3 Drawings and diagrams shall be used where necessary to enable the proper maintenance of the whole works.

4.8.4 The manual shall be suitably bound within a hard cover, and all materials used shall be reasonably hard wearing.

4.8.5 The manual shall be submitted to the Engineer. **This is a Hold Point.**

4.9 Samples and Models

If the nature of the works makes it desirable, the Contractor/Supplier may be asked to submit or prepare for the Engineer such samples, patterns and models as the Engineer may reasonably require for the purpose of design approval at the expense of the Contractor/Supplier.

4.10 Photographs

The Contractor/Supplier shall make all arrangements to provide progress photographs of all tests and such sections of the work in progress as directed by the Employer. Each photograph shall be of size 25 cm x 20 cm suitably titled. The negatives and/or electronic files of the photographs shall be the property

of the Employer and no prints from these negatives and/or electronic files shall be supplied to any persons unless under the authority of the Employer.

The Contractor/Supplier will normally be required to provide every month at his own cost the 3 (three) sets of unmounted progress photographs suitably inscribed, on portions of the work - in progress, throughout the period of construction. Any variation to these quantities will only be with the permission of the Employer.

Annex 4-1: Time Intervals for Document Submission, Test and Inspection Notification, and Number of Submission Copies

Item	Time Interval (Weeks)	Notification Period (Days)	No. of Copies
Submission of:			
Contract drawing list	4	-	5
Maintenance Manual	26	-	10
Method statement:			
• Overall	12	-	5
• Detailed	4	-	5
Work Programme		-	5
Reports:			
• Weekly reports	1	-	5
• Monthly reports	4	-	5
Quality Assurance Programme	4	-	5
Quality Plan	4	-	5
Preliminary supply and installation material manual	12	-	5
Time intervals:			
Currency of standards	4	-	-
Drawing approval	3	-	-
Profile approval and commencement of site work	x	-	-
Commencement of work after issue of notice	1	-	-
Suspension of work	1	-	-
Notification periods:			
Prototype test of towers - type test			
• overseas		28	
• local		7	
Sample test - overseas		14	
Inspection of work on site		3	
Final line inspection		14	
Commencement of survey		7	
Stringing of conductor across roads, etc.		7	
Number of copies:			
Drawings for approval			5
Approved drawings			5
Test program incl. prototype test of towers			5
Final supply installation material manuals			5
Installation instructions			6
Contract records:			
• Prints			1
• CDs			5
Test reports			5

Item	Time Interval (Weeks)	Notification Period (Days)	No. of Copies
Certificate of conformity			1
English language translation of "equivalent" standards			1
Applicable reference standards	4		1

Note: The time interval refers to the appropriate time period in weeks required before or after a specified event e.g. the Contract Drawing List shall be submitted at 4 week intervals, while the Applicable Reference Standards shall be submitted 4 weeks after signing of the contract.

Annex 4-2: Engineering Documents to be submitted by Contractor

Clause Reference	Document Description	Comment
4.5.3	Contract Drawing List	
4.5.4	Contract Record List	
4.5.5	Route Maps	
4.7	Supply and Install Material Manual	
4.8	Maintenance Manual	
4.10	Photographs	

Annex 4-3: Notification and Hold Points

Clause Reference	Notification Points	Hold Points
4.7		Supply and Install Material Manual
4.8		Maintenance Manual

Annex 4-4: Reference Standards

Thereferencestandardsandotherdocumentsreferredtointhis Sectionofthespecificationarelistedbelow:

- BS 308 Technical drawings
- ISO 5457 Size and layout of drawing sheets
- BS 5536 Recommendations for preparation of technical drawings for microfilming
- ISO 3272 Microfilming of technical drawings

5. Access

5.1 Wayleaves

5.1.1 General

5.1.1.1. A preliminary line route shall be provided by the Employer to enable the Contractor to start with the Contract works. The line route plan does not include facilities for storing material.

5.1.1.2. The Contractor will satisfy himself that the necessary rights of entry and access have been obtained before entry is affected.

5.1.1.3. The Contractor shall indicate to the Engineer such pipes or other obstructions, telephone, telegraph and power lines which infringe the clearances specified or otherwise fail to satisfy the requirements of the Specification.

5.1.1.4. The necessary permission for the removal of obstructions such as trees, houses, etc. and for the permanent removal or guarding of pipes, telegraph, telephone and power lines will be in the responsibility of the Contractor. The Employer may assist the Contractor in getting required permissions and permits.

5.1.2 Wayleave Schedule (not applicable)

5.2 Access to Site, Notice of Entry

5.2.1 Access Routes - General

5.2.1.1. The Contractor shall make all necessary arrangements for the general route for access to each or any position with the occupier as agreed by the Employer.

5.2.1.1. Subject to the provisions of the preceding paragraph the Contractor shall before commencing work, at his own expenses, do what is necessary to make the access suitable for his use and shall take all reasonable precautions to avoid damage, including, if required the erection of temporary fences or gates where permanent fences, hedges or gates have been removed. The Contractor shall not be entitled to any additional payment in the event of a particular access being difficult.

5.2.1.1. The Contractor shall be responsible for maintaining agreed access routes, without undue widening, in a usable condition for the duration of the Contract and the occupier shall not be put to any inconvenience in gaining access to his land or buildings. No unauthorized access route shall be taken by the Contractor.

5.2.2 Commencement of Work

The Contractor shall be responsible, before beginning work on any property for obtaining confirmation from the Engineer that wayleaves are in order and any agreed accesses, have not been altered and for giving not less than 48 hours' notice to the occupiers that work is to begin. Work shall proceed on any land within the requisite period of such notice being given to the occupier.

5.2.3 Suspension of Work

Where work is to be suspended without the expectation of it being resumed within the specified period, the Contractor must notify the occupier of such intention and shall similarly give the occupier prior notification of the resumption of work. The purpose of this clause is to assist in maintaining good relations between the occupier, the Contractor and the Employer and to keep the occupier informed of what is going to happen on or across his land.

5.2.4 Compliance with Occupier's Requirements

The Contractor shall at all times during the execution of the Works ensure compliance with all such reasonable requirements of the occupier as are brought to the Contractor's notice by the Engineer.

5.2.5 Notice to Authorities

Before the Contractor carries out the stringing of conductors alone, or across power or telecommunication circuits, public roads, etc., he shall give the requisite notice to the appropriate Authorities of the time and date when he proposes to perform the work and shall send a duplicate copy of each notice to the Engineer.

5.3 Route Clearance

For details of the clearance requirements for survey, access routes, line route, tower locations and conductor stringing please refer to **Annex5-1.**

5.4 Access Roads

Access roads/routes shall be identified by the Contractor themselves as and where necessary, and shall be constructed by them at their own expense and necessary compensations for damages thereof shall also be paid by the Contractor. The Employer's representative may assist the Contractor in his negotiations with the landowners about such compensation etc.

5.5 Crossing of Obstacles

5.5.1 General

The Contractor shall, at his own expense, make any necessary arrangements and take the necessary precautions where the route crosses buildings, telecommunication, power or pipe lines, orchards, gardens, railways, antiquities or other obstructions or ground over or across which erection cannot be carried out in the normal manner or has to be avoided. These arrangements must be submitted to the Engineer. **This is a Hold Point.**

Where a tower is set across a fence, hedge, bank or wall, the Contractor shall remove and reinstate the fence, hedge, bank or wall at his own expense and he shall be responsible at his own expense for making good to the satisfaction of the Engineer, owners and tenants concerned, all land, property, roads, drains, fences, walls, hedges, gates and the like which he has damaged or disturbed during the execution of tile Contract Works and shall remove all surplus material after erection. The Contractor shall take proper precautions to prevent the straying of and damage to livestock until after the backfilling of excavations and permanent reinstatement of fences, walls, hedges, gates and the like is completed.

Where the *Underground* line is set across a power line, telecommunication line, gas pipe line, sewerage line, drain, fence, hedge, bank or wall etc. and in case the said existing installation cannot be by passed through re-route, the Contractor shall remove and reinstate the existing installation at his own expense and he shall be responsible at his own expense for making good to the satisfaction of the Employer, owners and tenants concerned, all land, property, roads, drains, fences, walls, hedges, gates and the like which he has damaged or disturbed during the execution of the Contract Works and shall remove all surplus material after installation. The Contractor shall take proper precautions to prevent the straying of and damage to livestock until after the backfilling of excavations and permanent reinstatement of such installation which is completed.

5.5.2 Public Utilities

The Contractor shall obtain all necessary permissions, licenses or approvals from authorities which are required for any part of the work. The Employer shall assist the Contractor in obtaining those permissions. All costs for such permissions shall deem to be included in the Contract Price.

The Contractor shall ensure that the erection of the Contract Works does not cause damage to or interference with existing telecommunication, power or pipe lines.

Where appropriate Authorities affected deem it necessary for the protection of their employees, property, or the public or for the assistance of traffic to provide flagmen and watchmen, the cost of such provision shall be borne by the Contractor. Where required by the appropriate Authorities work shall be carried on outside normal hours and at the Contractor's own expense.

The Contractor shall also be liable to make good at least to the original condition or compensate the owners, operators and users or any public undertaking in respect of any damage however caused to their property, lands or roads arising, out of or in consequence of the execution of the Works.

5.5.3 Scaffolding

The Contractor shall provide all necessary scaffolding and the like for the crossing of telecommunications or power lines, roads, railways buildings or other obstacles. The Contractor shall advise the Employer in each instance of the scaffolding he proposes to use. Drawings of the proposed scaffolding shall be submitted to the Employer, and the appropriate regulatory authorities for approval. **This is Hold Point.**

5.5.4 Live Line Scaffolds

The scaffolding which is used to cross specified low, medium and high voltage power lines shall be of such dimensions and allow such clearances that the power lines being crossed may remain in commission during construction of the new transmission line. Shutdowns on the lines to be crossed may be given for construction of new line but shall not be given continuously for longer periods. Such restrictions in building and use of the scaffolds shall not be grounds for claiming additional costs. Design and construction of the live line scaffold shall not be inferior to the minimum standards outlined in the following clauses.

5.5.5 Live Line Scaffolds - Construction

5.5.5.1. The scaffold shall be designed to withstand the maximum design wind speed, except that a reduced return period will be accepted. Consideration shall also be given due to impact loading, due to dropping of the upper phase conductor.

5.5.5.2. The scaffold shall, unless otherwise approved by the Employer, consist of 3 m wide 300 mm square mesh nylon nets attached to steel wire ropes running perpendicular to the lower line route, carried by metal scaffolding at 3 m intervals. The nets shall be attached to the catenary wires by means that do not require the presence of any persons on the net or the catenary wires whilst the lower line is alive. An additional movable walk net laid over the 300 mesh nets may be used whilst the lower line is dead.

5.5.5.3. Normally steel or aluminium tubular scaffolding to BS 1139 and BS 6323, should be used, the use of performed units or frames shall be subject to the Employer's approval.

5.5.5.4. The mechanical construction shall be in accordance with BS 5950. Reference shall also be made where appropriate to BS 5973.

5.5.5.5. The design of the scaffold shall have due regard to the requirements of safety with particular respect to accidental contact with live conductors during construction, use and removal.

5.5.5.6. The scaffold including foundations shall be designed and constructed to ensure stability during the process of erection and removal, and also at times when work has ceased for any reason including adverse weather conditions. The foundations shall be suitable for the ground concerned.

5.5.5.7. The scaffold shall extend at least 5 m either side of the outermost conductors of the upper line. A maximum of 2 m of this distance may be provided by means of catchers.

5.5.5.8. Catchers shall be provided at each end of each scaffold support. The catchers may be vertical or inclined to a maximum angle of 450 from the vertical. They shall be capable of withstanding

the specified impact loads without excessive distortion that would permit a falling conductor to approach or touch a live-line.

5.5.5.9. The upper parts of the scaffold shall be provided with soft wood rubbing boards or otherwise protected in an approved manner to prevent damage to the conductors resting on or being drawn over the guard. Soft wood poles may be used for this purpose. The height of these boards shall be sufficient to prevent the conductor damaging the nylon net. To avoid damaging the conductors no object other than non-metallic lashing or the catchers shall protrude above the rubbing boards.

5.5.5.10. Sufficient endless or double ended lead lines for hauling over pilot wires shall be placed over the scaffold prior to re-energising of the lower line.

5.5.5.11. The side supports shall have working platforms to facilitate the required running of conductors and pilot wires. Working platforms shall be provided with hand rails, toe boards and notices warning of the danger of live conductors. The heights of hand rails shall be 1m and the toe boards 230 mm. Each working platform shall have a notice plate indicating the 'Safe Climbing Height'.

5.5.5.12. The scaffolds shall be fitted with danger plates at intervals of not more than 6m along the anticlimbing device with at least one plate on each face of the structure.

5.5.5.13. The scaffolds shall be constructed to prevent unauthorised access or climbing by the use of barbed wire anti-climbing devices, fences or other means approved by the Employer.

5.5.5.14. The scaffolding shall be lit with red warning lamps from 1/2 hour before sunset to 1/2 hour after sunrise if erected within 2m from a highway or footpath without an intervening fence. The scaffold Contractor shall provide or arrange for the supply and/or maintenance of these lamps (e.g. with the line Contractor).

5.5.5.15. If the scaffolding is constructed adjacent to a roadway, a guard constructed from steel drums filled with soil or a soil bund shall be provided and suitably lit.

5.5.5.16. Where possible the resistance to earth of the scaffold shall be less than 10 ohms. Special consideration by the Employer and the lower line operator shall be given in cases where this is not attainable with a reasonable number of driven earth rods.

5.5.5.17. Bonding the scaffold to the earthing systems of either the live-line, or the line under construction is not normally acceptable. In the former case a nearby line fault could cause the scaffold to become live. In the latter case a fault between the live-line and the scaffold could cause components of the line under construction to become alive, particularly as it earthing system may not be complete.

5.5.5.18. The earth rods should normally be driven into the ground around the outside and approximately 1m from the scaffold structure. The rods should be securely connected electrically and mechanically to the scaffold structure by flexible copper or aluminium leads with minimum cross-sectional areas of 64 mm² or 100 mm² respectively.

5.5.5.19. Drawings of the scaffold, complete with details of the clearance plates and earthing arrangement, together with supporting, calculations shall be submitted to the Employer and appropriate regulatory authorities for approval. **This is a Hold Point.**

5.6 Damage

5.6.1 General

The Contractor shall take all reasonable precautions to avoid damage to land, property, roads, crops, field drains, fences walls, hedges, gates, trees and the like and shall ensure that the work is adequately supervised so that any damage is reduced to the minimum. The Contractor shall pay compensation to the owners/tenants for damages of crops, trees and houses during the project implementation within the wayleaves (right-of-way) which are unavoidable for construction of the transmission line. The Employer's representative shall assist the Contractor in his negotiations with the landowners about such compensation.

5.6.2 Contractor's Responsibility

The Contractor's liability for loss or damage shall extend to any such loss or damage resulting from the employment of a Subcontractor. This does not relieve the Contractor of his liability for all actions of his Subcontractor.

5.6.3 Livestock, Dogs

Adequate provision shall be made by the Contractor to prevent the straying of or injury to livestock during the execution of the Works and until the permanent reinstatement of fences, walls, hedges, gates and the like is completed.

The Contractor shall not bring any dog on or near the site or suffer or permit any of his employees, representatives or agents or any Subcontractor to bring any dog on or near the site and shall cause the immediate removal of any dog which may be on or near the Site in breach of this provision.

The Contractor shall be liable for any injury to or loss of livestock due in the opinion of the Engineer to failure to comply with the above requirements.

Annex 5-1: Route Clearance

Where clearing is in the opinion of the Employer necessary, the following requirements shall be observed. Trees and tall scrub shall be cleared to a distance of 14 m for 132 kV,20 m for 230 kV and 23m for 400kV on either side of the centreline of the route. Trees and bushes shall be cut down to a height of not more than 1.0 m above ground level. In addition, tall trees outside the cleared area, of such height that they could fall within 2 m of conductors, shall be trimmed by the Contractor. No tree may be felled without the express permission of the Employer. **This is a Hold Point.**

Felled trees and scrub shall be removed from a path 3.5 m wide and running as far as possible continuously along the route. The Contractor shall grub up tree stumps and roots from this track.

All trees, bushes, bamboo and any other vegetation which normally grows to a height of 2.5 m or more shall be treated by an approved non-toxic, non-residual agent to prevent further growth.

The Contractor shall clear a 3.5 m wide agreed construction access track from public roads, of all trees, stumps, scrub and vegetation to tower positions as required by the Employer.

All felled trees or tree trimmings shall remain the property of the landowner.

The Contractor shall be responsible to take clearance from relevant authorities. The Employer shall cooperate in this regard.

Annex 5-2: Access Roads

Access roads/routes shall be identified by the Contractor themselves as and where necessary, and shall be constructed by them at their own expense and necessary compensations for damages thereof shall also be paid by the Contractor. The Employer's representative shall assist the Contractor in his negotiations with the landowners about such compensation etc.

Annex 5-3: Engineering Documents to be Submitted by Contractor

Clause Reference	Document Description	Comment
5.3	Route Clearance	
5.5.3	Scaffolding	
5.5.4	Live Line Scaffolding	

Annex 5-4: Notification and Hold Points

Clause Reference	Notification Points	Hold Points
5.3		Route Clearance
5.5		Crossing of obstacles
5.5.3		Scaffolding drawings
5.5.5		Live line scaffold drawings

Annex 5-5: Reference Standards

Thereferencestandardsandotherdocumentsreferredtointhis Sectionofthespecificationarelistedbelow:

- BS 1139 Metal scaffolding
- BS 5950 Structural use of steel work in building
- BS EN 12811-1 Code of practice for access and working scaffolds and special scaffold structures in steel
- BS 6323 Specification for seamless and welded steel tubes for automobile, mechanical and general engineering purposes.
- BS EN 12810-1 Facade Scaffolds
- EN 10296/10297/10305 Welded circular steel tubes/seamless circular tubes/steel tubes for precision application

6. Survey, Profile, Geotechnical Investigations and Field Quality Plan

6.1 General Information & Scope of Work

6.1.1. The Engineer will indicate to the Contractor either on maps or during visits to the sites the proposed route of the transmission line, with approximate positions of the angle and terminal towers and the positions of such intermediate towers as it may have been desirable to determine during preliminary wayleave negotiations. The Contractor shall give the Engineer the requisite period of notice prior to commencing the survey. **This is a Hold Point.**

6.1.2. The technical specifications covers detailed survey including route alignment based on the intermediate GPS readings & Tentative route alignment finalized by the Employer, profiling, tower spotting, optimization of locations, check survey, contouring, and soil investigation for the transmission lines / part of the transmission lines covered under this specification as included in the schedule of prices.

6.1.3. Contractor shall provide at site all required survey instruments to the satisfactions of the Employer so that the work can be carried out accurately according to specifications and drawings. The Contractor shall arrange to collect the data regarding change of course of rivers, major natural streams and canals, etc., encountered along the transmission line route from the best available sources and shall furnish complete hydrological details including maximum velocity discharge, highest flood level (H.F.L), scour depth etc. of the concerned rivers, major streams and canals.

6.1.4. The **scope of work** shall include the following:

a. Detailed survey using GPS, Total work stations, long range scanners &digital theodolite of reasonable accuracies or alternatively using ALTM (Airborne Laser Terrain Modelling) techniques, inter-alia including:
   - Digitized profiling along the selected route along with plan details.
   - Computer aided tower spotting & optimization
   - Soil resistivity measurement along the route

b. Check survey including digitized contouring at undulated / hilly tower locations;

c. Soil Investigation;

d. Preparation of survey reports including estimation of bill of quantities, identification and explanation of route constraints (like forest, animal/bird sanctuary, reserve coal belt areas, oil pipeline /underground inflammable pipe lines etc.), infrastructure details available en-route etc.

6.1.5. The **provisional quantities** for the scope of work are indicated in relevant Price Schedules of the bidding documents. The final quantities for route alignment & detailed survey (quantities in "km" unit) shall be the horizontal **route** length along the approved route alignment. The route alignment, detailed survey, including profiling & tower spotting, contouring, soil investigation, etc. shall be carried out by the Contractor as per the technical specifications stipulated herein.

6.1.6. The Contractor must note that the Employer shall not be responsible for loss or damage to properties, trees etc. due to Contractor's work during survey. The Contractor shall indemnify the Employer for any loss or damage to properties, trees etc. during the survey work.

6.1.7. The Contractor should note that Employer will not furnish topographical maps but will make available assistance that may be required in obtaining these by providing letters of recommendation to

the concerned authorities. Further, in case the Contractor opts for use of ALTM techniques for detailed survey, he shall be responsible for obtaining necessary clearances/permissions, as may be required from concerned authorities. The Employer will provide assistance that may be required in obtaining these clearances/ permissions by providing letters of recommendation to the concerned authorities.

6.1.8. The work shall be carried out by the Contractor using modern surveying techniques.

6.1.9. The Contractor shall also engage services of a reputed geo-technical/geologist consultant or experts from independent educational/research institutions for examining stability aspects of the selected transmission line route & tower locations in hilly terrain during finalization of tower spotting & construction of foundations.

6.1.10. After carrying out the detailed survey and soil investigations, the Contractor shall estimate complete BoQ of the transmission line(s) and submit the same as per the format of the 'Schedule of Prices' to the Employer.

6.2 Contractor's Survey

6.2.1 Access for Survey

For details of the access arrangement for survey, please refer to **Annex 5-1**. The Contractor's Surveyor shall in all cases announce himself to the occupier/landowner immediately before entering any private property for the purpose of survey. The Contractor shall comply with all national and local regulations regarding barricades, detour arrangements, and warning signs. Damage to roads, footpaths, bridges, ditches, etc., caused by the Contractor shall be repaired at his expense.

6.2.2 Survey Methodology & Precision

6.2.2.1 Survey Methodology

6.2.2.1.1. All elevations shall be referenced to benchmarks established by the Public Work Division of Bangladesh / Survey of Bangladesh. Survey operations shall begin and end at benchmarks approved by the Employer.

6.2.2.1.2. During the levelling of the profile, check surveys will be affected at intervals not exceeding 50 km with benchmarks of known elevations. The difference in elevations as surveyed by the Contractor and as declared by Public Work Division of Bangladesh / Survey of Bangladesh for these benchmarks shall not exceed the precision required for 3rd order surveys $e \leq 24k$ where k is the distance between benchmarks in km and e is the difference between elevations in mm but not exceed 300 mm.

6.2.2.1.3. In the absence of suitable benchmarks the levelling shall be done by two independent levelling parties working in opposite directions along the same line. The difference in elevations between the two surveys shall not exceed the precision required for 3rd order surveys as stated above.

6.2.2.1.4. All important objects and features along the transmission line centreline (railways, highways, roads, canals, rivers, transmission lines, distribution lines, telephone lines etc.) shall be surveyed and located with a positional accuracy of 1:2000 between points of known horizontal position.

6.2.2.1.5. Contractor shall survey a corridor along a line route, not just the centreline. The width of the corridor will be at least as per the following table:

Transmission Line	Survey Width
132kV	30m (15m from the centre line either side)
230kV	50m (25m from the centre line either side)
400 kV	60m (30 m from the centre line either side)

6.2.2.1.6. The data density shall be as per Clause no. 6.2.6.1. A centre line survey for pegging shall still be required following the approved plan and profile drawings.

6.2.2.1.7. The XYZ survey measurements can be obtained by using one or more of the following methods:

- Aerial photogrammetry;
- Flying the route by helicopter or fixed wing aircraft using specialized aerial laser scanning instruments for Aerial Laser Surveys (ALS);
- Ground survey using GPS or electronic distance measuring equipment.

6.2.2.1.8. All these methods of survey measurements should capture information as per the proposed feature codes.

6.2.2.2 Survey Accuracy

Photogrammetry

The accuracy of any point on the ground corridor profile shall be ± 1m horizontal and ± 0.25m vertical. A DXF file shall be imported into PLS CADD.The Contractor may choose to do the survey manually (cf. clause 1.3) or use GPS or laser. In every case, the geo-referenced ECW file for topographic image would be very helpful.

Laser Scanning

The accuracy of any point on the ground corridor profile shall be ± 0.15m horizontal and ± 0.15m vertical from absolute position. A LAS file will be imported into PLS CADD.

GPS

The accuracy of any point on the ground corridor profile shall be ± 1m horizontal and ± 0.3m vertical. The accuracy is governed by the type of GPS used, availability of satellites, Geoid model for the relevant area and vegetation. Accuracy is in the order of ± 1m horizontal and ± 2m vertical for differential GPS, ± 0.025m horizontal and ± 0.05 vertical for RTK GPS.

6.2.3 Route Alignment

6.2.3.1. The route alignment shall be carried out by the Contractor using topographical maps and preliminary route alignment finalized by the Employer with GPS.

6.2.3.2. The routing of the transmission line shall be most economical from the point of view of construction and maintenance. The Contractor shall identify & examine alternative route alignments and suggest to the Employer the optimal route alignment.

6.2.3.3. Routing of transmission line through protected/reserved forest area should be avoided. In case it is not possible to avoid the forests or areas having.

6.2.3.4. Large trees completely, then keeping in view of the overall economy, the route should be aligned in such a way that cutting of trees is minimum.

6.2.3.5. The route should have minimum crossings of major river, national/state highways, overhead EHV power line and communication lines.

6.2.3.6. The number of angle points shall be kept to minimum.

6.2.3.7. The distance between the terminal points specified shall be kept shortest possible, consistent with the terrain that is encountered.

6.2.3.8. Marshy and low lying areas, river beds and earth slip zones shall be avoided to minimize risk to the foundations.

6.2.3.9. It would be preferable to utilize level ground for the alignment.

6.2.3.10. Crossing of power lines shall be minimized. Alignment will be kept at a minimum distance of 300 m from power lines to avoid induction problems on the lower voltage lines.

6.2.3.11. Crossing of communication line shall be minimized and it shall be preferably at right angle. Proximity and parallelism with telecom lines shall be eliminated to avoid danger of induction to them.

6.2.3.12. Areas subjected to flooding such as canals shall be avoided.

6.2.3.13. Restricted areas such as civil and military airfield shall be avoided. Care shall also be taken to avoid aircraft landing approaches.

6.2.3.14. All alignment should be easily accessible both in dry and rainy seasons to enable maintenance throughout the year.

6.2.3.15. Certain areas such as quarry sites, tea, tobacco and saffron fields and rich plantations, gardens & nurseries which will present the Employer problems in acquisition of right of way and way leave clearance during construction and maintenance should be avoided.

6.2.3.16. Angle points should be selected such that shifting of the point within 100 m radius is possible at the time of construction of the line.

6.2.3.17. The line routing should avoid large habitations, densely populated areas, forest, animal /bird sanctuary, reserve coal belt areas, oil pipe line/underground inflammable pipe lines etc. to the extent possible.

6.2.3.18. The areas requiring special foundations and those prone to flooding should be avoided.

6.2.3.19. For examination of the alternatives & identification of the most appropriate route, besides making use of information/data/details available/extracted through, the Contractor shall also carryout reconnaissance /preliminary survey as may be required for verification & collection of additional information / data / details.

6.2.3.20. The Contractor shall submit his preliminary observations & suggestions along with various information/data /details collected and also processed satellite imagery data, scanned topographical map data marked with the alternative routes etc. The final evaluation of the alternative routes shall be conducted by the Contractor in consultation with Employer's representatives and optimal route

alignment shall be proposed by the Contractor. Digital terrain modelling using contour data from topographical maps shall be done by the Contractor for the selected route. A fly through perspective using suitable software(s) shall be developed for further refinement of the selected route, if required. Site visit and field verification shall be conducted by the Contractor jointly with the Employer's representative for the proposed route alignment.

6.2.3.21. Final digitized route alignment drawing with latest topographical and other details/features including all rivers, railway lines, canals, roads etc. up to 8 km on both sides of selected route alignment shall be submitted by the Contractor for Employer's approval along with report containing other information /details as mentioned above.

6.2.3.22. Changes in the route alignment, if any, during detail survey, shall be incorporated in the final digitized route alignment drawings.

6.2.4 Detailed Survey

6.2.4.1 The detailed survey shall be carried out using GPS, Total stations, digital theodolites etc. along the approved route alignment. As an alternative, the Contractor may also use ALTM (Airborne Laser Terrain Modelling) techniques of equal or better accuracy for the detailed survey.

6.2.4.2 Soil resistivity, along the route alignment shall be measured in dry weather by four electrode method keeping inter-electrode spacing of 50 metres. For calculating soil resistivity formula$2\pi ar$ (Where a = 50m and r = megger reading in ohms) shall be adopted. Measurement shall be made at every 2 to 3 km along the length of the route. In case soil characteristics changes within 2 to 3 km, values shall have to be measured at intermediate locations also. Megger reading and soil characteristics should also be indicated in the soil resistivity results.

6.2.5 Route Marking

6.2.5.1 The route of the transmission line shall be recorded using GPS/DGPS of positional accuracy as per clause no. 6.2.2.2.

6.2.5.2 The coordinates of all the angle points as well as other important crossings, landmarks etc. shall be recorded using GPS for easy relocating.

6.2.5.3 At the starting point of the commencement of route survey; the coordinates shall be recorded. A punch mark on the top section of the angle iron shall be made to indicate the location of the survey instrument. The coordinates of the location of the survey instrument shall also be recorded. Further, the coordinates at prominent position at intervals of not more than 750 meter along the transmission line to be surveyed up to the next angle point shall also be recorded. Wooden pegs of 50 x 50 x 650 mm size shall also be driven at prominent position at intervals of not more than 750 m along the transmission line to be surveyed up to the next angle point. Wire nails of 100mm length should be fixed on the top of these pegs to show the location of instrument. The peg shall be driven firmly into the ground to project 100 mm only above ground. Wherever the line alignment crosses the EHT line, railway line, P&T line or roads, the Contractor shall record coordinates on the points of crossing. Wherever line route alignment passes over permanent land marks such as rock, boulders, culverts etc. suitable white paint marks with directional and Employer markings shall be made and coordinates recorded. At angle position stone/concrete pillars of 150 x 150 x 100 mm in size with Employer marked on them shall be embedded into the ground for easy identification.

6.2.6 Profiling

6.2.6.1 The complete profiling along the route shall be carried out using modern surveying equipment viz. Total stations, DGPS etc. Reference levels (R/Ls) at an interval of 5m in Plain terrain and 1m in hilly terrain along the route are to be presented. Besides the centre line survey data all survey data points within the corridor mentioned in clause no. 6.2.2.1.5 shall be presented in the computer-aided tower spotting software (PLSCADD) at a grid of 5mx5m (1mx1m preferable) for plain terrain and 1mx1m (0.5mx0.5m preferable) for hilly terrain. R/Ls at other undulations along the route as well as in the route plan and other route details viz. crossings, building & structures, power lines, ponds, canal, rivers, gardens, trees & other infrastructure etc. shall also be recorded. Areas along the route, which in the view of the Contractor, are not suitable for tower spotting, shall also be marked.

6.2.6.2 The complete profiling details shall be digitized and the data shall be prepared & stored in the format compatible to computer-aided tower spotting software.

6.2.6.3 A printed/plotted output of the digitized profiling shall be submitted by the Contractor to the Employer's for review before taking up computer-aided tower spotting.

6.2.7 Optimization of Tower Location / Tower Spotting

6.2.7.1 Optimization of tower locations including profiling shall be done by the Contractor using computer-aided tower spotting software (PLSCADD) and shall furnish sample calculations and manual tower spotting drawings for some typical sections.

6.2.7.2 The sag-tension characteristics of the conductor as well as tower spotting data shall be furnished by the Employer to the Contractor during execution stage. Sag template curves, if any required for Employer's spotting purposes, shall be prepared by the Contractor.

6.2.7.3 General description of towers is indicated in Section-I of this specification for information of the Bidders.

6.2.8 Tower Spotting

The Contractor shall submit to the Engineer the requisite copies of route maps, they shall also submit requisite copies of the profile drawings upon which shall be indicated the proposed location and type of each tower, spans, section lengths, (i.e.) distances between tension towers), equivalent spans, wind and weight span, difference in level between phase conductor attachment points and the sag templates used. **This a Hold Point.** Also on the profile shall be plotted the relevant position of the bottom or lowest phase conductor at the specified maximum conductor temperature and another line parallel to the phase conductor line and at the minimum statutory ground clearance specified below it.

Towers shall be so located that the span criteria specified in **Annex 8-5** is not exceeded.

While profiling & spotting the towers, the following shall be borne in mind:

a) Span

The number of consecutive spans between the section points shall not exceed 15 spans or 5 km in plain terrain and 10 spans or 3km in hilly terrain. A section point shall comprise of tension point with a section tower as mentioned in the **Annex** of 'Tower' section.

b) Extension/Truncation

An individual span shall be as near to the normal design span as possible. In case an individual span becomes too short with normal supports on account of undulations in ground profile, one or both the supports of the span may be extended by inserting standard body/leg extension. In case of locations where the ground clearance is available, truncated towers may be spotted. The provisions kept in the design of towers w.r.t. body/leg extensions, truncations shall be intimated to the Contractor by the Employer during execution stage.

c) Loading

There shall not be any upward force on suspension towers under normal working conditions and the suspension towers shall support at least the minimum weight span as provided in the designs. In case uplift is unavoidable, it shall be examined if the same can be overcome by adding standard body extensions to the towers failing which tension towers designed for the purpose shall be deployed at such positions.

d) Road Crossing

At all important road crossings, the tower shall be fitted with normal suspension and tension insulator strings depending on the type of tower, but the ground clearance at the roads under maximum temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces will not be less than specified minimum ground clearance.

e) Railway Crossings

All the railway crossings coming along the transmission line route shall be identified by the Contractor. At the time of detailed survey, the railway crossings shall be finalized as per the regulation laid down by the Railway Authorities.

- The crossing shall normally be at right angle to the railway track.
- The minimum distance of the crossing tower shall be at least equal to the height of the tower plus 6 meters away measured from the centre of the nearest railway track.
- No crossing shall be located over a booster transformer, traction switching station, traction Substation or a track cabin location in an electrified area.
- Minimum ground clearance above rail level of the lowest portion of any conductor under condition of maximum sag shall be maintained as mentioned in the **Annex**.

f) Power line Crossings

The angle of crossing shall be as near to 90 degree possible. In order to reduce the height of the crossing towers, it may be advantageous to remove the ground-wire of the line to be crossed (if this is possible and permitted by the Employer of the line to be crossed).

Minimum clearance in meters between lines when crossing each other is mentioned in **Annex.**

Pipeline crossings shall be as per provision mentioned in **Annex**.

g) Telecommunication Line Crossings

The angle of crossing shall be as near to 90 degree possible. However, deviation to the extent of 30 degree may be permitted under exceptionally difficult situations. At the crossing of power supply and telecommunication circuits, no part of the structure of one support shall be placed less than 35 m from any part of the support structure of the other circuit.

When the angle of crossing has to be below 60 degree, the matter will be referred to the authority in charge of the telecommunication System. On a request from the Contractor, the permission of the telecommunication authority may be obtained by the Employer.

Also, in the crossing span, power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires.

h) River Crossings

When the transmission line crosses a river or closely runs parallel to a river, data regarding historical bank line movement, future development, geo-morphology and hydrostatics of that river (as stated in **Article 6.8**) should be collected and analyzed. Based on the analysis, most stable route for the transmission line to cross the river should be proposed in the route survey report.

During finalization of river crossing route, shortest feasible width of the river should be taken into consideration. Optimization of tower locations and minimum angle deviation should also be taken into consideration during finalization of river crossing route.

i) Details En-route

All topographical details, permanent features, such as trees, building etc. within the width (either side) mentioned in the Annex shall be detailed on the profile plan.

6.2.9 Clearance from Ground, Building, Trees etc.

6.2.9.1. Clearance from relevant structures shall be provided in conformity with criteria specified in **Annex6-1.**

6.2.9.2. The Contractor shall count, mark and put proper numbers with suitable quality of paint at his own cost on all the trees that are to be cut (By the Contractor) at the time of actual execution of the work as detailed below. The Contractor may please note that Employer shall not pay any compensation for any loss or damage to the properties or for tree cutting due to Contractor's work.

6.2.9.3. To evaluate and tabulate the trees and bushes coming within the width mentioned in “Access” Section on either side of the central line alignment the trees will be numbered and marked with quality paint serially from angle point 1 onwards and the corresponding number will be painted on the stem of trees at a height of 1 meter from ground level. The trees list should contain the following:

a. Girth (circumstances) measured at a height of 1 meter from ground level.
b. Approximate height of the tree with an accuracy of +2 meters.
c. Name of the type of the species/tree.
d. The bushy and under growth encountered within the 40m should also be evaluated with its type, height, girth and area in square meters, clearly indicating the growth in the tree/bush statement.

6.2.9.4. The Contractor shall also identify the forest/non-forest areas involved duly authenticated by concerned authorities as follows:

a. A statement of forest areas with survey/compartment numbers (all types of forest RF / PF / acquired forest / revenue forest / private forest / forest as per dictionary meaning of forest etc.)
b. A statement of non-forest areas with survey/compartment numbers
c. Tree cutting details (girth-wise & specie-wise)
d. Marking of forest areas with category on topology sheets 1:250,000 showing complete line route, boundaries of various forest divisions and their areas involved.
e. Village forest maps of affected line and affected forest area and marking of the same.
f. Forest division map showing line and affected forest area.

6.2.10 Preliminary Schedule

The profile sheets showing the locations of the towers together with preliminary schedules of quantities indicating tower types, wind & weight spans, angle of deviation, crossing & other details etc. shall be submitted by the Contractor for review & approval by Employer's Site Engineer in charge.

6.2.11 Profile Drawings - Size & Scales

6.2.11.1. The profile shall either be drawn on a melinex type material or as otherwise approved with printed grid lines of increasing thickness in 1, 5, 10 and 50 mm squares and shall be drawn on the reverse side of the melinex to the grid lines.

6.2.11.2. Computer-plotted profiles on plain plastic drawing sheets will be accepted by the Engineer. However, the format of the profile shall not differ from the details specified in the following clauses.

6.2.11.3. Unless specified to the contrary the scale of the profile shall be:

- 1:2000 horizontally and
- 1:200 vertically

6.2.11.4. The profile shall be plotted with the direction of the line route left to right on the profile sheet. In general, individual profile sheets shall commence and finish at tension supports but where this is not practicable and continuation sheets are found to be necessary the ground line is to be drawn so that there is an overlap of at least 300 mm between adjacent sheets. The chainage of each section between tension structures shall start at zero, be on a 50 mm printed grid line and not less than 200 mm from the left hand margin. Each section shall normally be started on a new sheet. The date of survey of each section shall be added.

6.2.11.5. If more than one section is drawn on one sheet a gap shall be left in the ground line of not less than 200 mm.

6.2.12 Profile Drawings-Details

The following details and information are to be included in the profile drawings:

a. At each angle position a 'tie-in' sketch shall be provided on the profile sheet. This sketch shall show clearly the location of the support using as reference where possible points which can be located on the ground and on the 1:5,000 or closest available scale of survey map. The direction of the line and angle of deviation are to be shown stating also whether the deviation is left or right. Where reliable maps of reasonable scale and accuracy are not available for locating and plotting support positions, survey methods acceptable to the Engineer shall be employed to establish grid coordinates and supports towers and ground features shall be related to these.

b. Where ground slope across the line route exceeds 1 in 25, the level of ground left and right of the centre line shall be recorded at specified horizontal offset distances, where the side slope is uniform. Where the slope breaks upwards beyond this distance levels will be recorded up to a specified horizontal offset distance. The offset levels shall be indicated on the profile as broken and/or chain lines and the distances off-line stated.

c. The profile shall show all changes of level of 300 mm or more along the route centre line and alone, the off-set lines. All features such as hedges, fences, graves, ditches, roads, railways,

rivers, buildings, canals, telephone and railway lines and all power lines shall be shown. Road numbers or name of roads shall be stated or, if unclassified, the destination. Railways are to be given the destination, number of tracks, whether or not electrified and the level at the top of rail stated.

d. The chainage is to be shown at each 300m and at every geographical feature or obstruction. Chainage shall also be given to all line pegs.

e. The specified Datum shall be the basis for all levels and the level above the specified Datum shall be shown at 10m vertical intervals at the beginning and end of each profile sheet. Levels shall be shown at each peg on line and at every obstruction or geographical feature.

f. The visual nature of the ground shall be noted, whether cultivated, woodlands, etc. with special reference to marsh, soft ground or rock and other relevant information such as soil instability.

g. All buildings or high obstructions within 30m of the centre line shall be shown dotted at their measured height with the distance left or right of line indicated.

h. Where the ground contour rises to a point which would be less than 100 mm from the top of the profile sheet, the ground line shall be terminated and continued on a new sheet with an overlap of 300m of line route.

i. The following detail shall be shown for crossings of power lines:
    a. Voltage and type of construction;
    b. Ground levels at point of crossing and support structures;
    c. Height of top conductor and earth wire at point of crossing and at points of support;
    d. Distance from crossing point to support structures along route of line to be crossed;
    e. Angle of crossing;
    f. Temperature at time levels were taken (state date and time);
    g. Support structure numbers.
    h. Any other information requested by the Employer's Engineer.

j. Along the bottom of the profile sheet shall be drawn, to the same scale as the horizontal scale of the profile, a route map showing all relevant details, within a distance of 30m each side of the route centre line. All items covered by subparagraphs (a) and (i) above, as appropriate, shall be included.

6.2.13 Check Survey

The Contractor shall carry out a check survey of the whole route. Profile drawings will be made available to the Contractor, who will be required to check the profile (ground line) survey. The line routes may need to be changed at some locations due to site constraints. The Contractor shall propose such changes after surveying the new line routes. No extra cost for survey and preparation of all drawings of such change of route will be paid to the Contractor.

The Contractor is required to check thereon the proposed tower positions and submit the profile drawing to the Engineer. Profile details and tower locations shall be in accordance with the preceding clauses.

6.2.14 Survey Report

6.2.14.1. Complete BoQ of the transmission lines as per the format given in the 'Schedule of Prices' shall be furnished after approval of Plan & Profile.

6.2.14.2. Each angle point locations shall be shown with detailed sketches showing existing close by permanent land marks such as specific tree(s), cattle shed, homes, tube wells, temples, electric pole /tower, telephone pole, canal, roads, railway lines etc. The relative distance of landmarks from the angle points and their bearings shall be indicated in the sketch. These details shall be included in the survey report.

6.2.14.3. Information w.r.t infrastructure details available en-route, identification and explanation of route constraints, etc. shall also be furnished in the Survey report and shall inter-alia include the following:

6.2.14.4. Information regarding infrastructural facilities available along the final route alignment like access to roads, railway stations, construction material sources (like quarry points for stone, sand and availability of construction water), labour, existing transport facilities, fuel availability etc. shall be furnished in the survey report.

6.2.14.5. All observations which the Contractor thinks would be useful to the construction of the transmission lines mentioned under scope of work are to be reported.

6.2.14.6. Suggestions regarding the number of convenient zones (line segments / portions) in which the entire alignment can be divided keeping in view the convenience of corporation are to be given.

6.2.14.7. Suggestions regarding location for setting up stores during line construction in consultation with Employer's representative shall also be provided by the Contractor.

6.2.14.8. Working months available during various seasons along the final route alignment, with period, time of sowing & harvesting of different type of crops and the importance attached to the crops particularly in the context of way leave problems and compensation payable shall be stated by the Contractor.

6.2.14.9. Availability of labour of various categories and Contractors of civil works shall also be reported.

6.2.14.10. Some portions of the line may require clearance from various authorities. The Contractor shall indicate the portion of the line so affected, the nature of clearance required and the name of concerned organizations such as local bodies, municipalities, P&T (name of circle), Inland navigation, Irrigation Department, Power Utilities and Divisional Forest/ wild life Authorities etc.

6.2.14.11. All safety regulation shall be complied by the Contractor during routing / survey /construction of line through patches of dense forest/wild life. The Employer has, however, obtained forest clearance on the basis of tentative route alignment.

6.2.14.12. All the requisite data for processing the case for statutory clearances shall be provided along with the report.

6.2.14.13. The Contractor shall also collect & report details pertaining to pollution levels envisaged along the transmission line.

6.2.14.14. Six copies of survey reports shall be furnished by the Contractor to the Employer.

6.3 Geotechnical Investigation

6.3.1 General

6.3.1.1 Geotechnical investigation shall be undertaken in accordance with the technical requirements detailed in the following clauses. For details of the type and frequency of the investigation reference should be made to **Annex 6-2**.

6.3.1.2 Employer requires that a detailed Geotechnical investigation be carried out at various tower locations to provide the designer with sufficiently accurate information, both general and specific, about the substrata profile and relevant soil and rock parameters at site on the basis of which the foundation of transmission line towers can be classified and designed rationally.

6.3.1.3 All investigation, unless specified otherwise shall be in accordance with the requirements of BS 5930.

6.3.1.4 These specifications provide general guidelines for geotechnical investigation of normal soils. Cases of marshy locations and locations affected by salt water or saltpetre shall be treated as special locations and the corresponding description in these specifications shall apply. Any other information required for such locations shall be obtained by Contractor and furnished to Employer.

6.3.1.5 The Contractor shall give the Engineer the requisite period of notice prior to commencing the geotechnical investigation. **This is a Hold Point.**

6.3.2 Scope

6.3.2.1. The scope of work includes detail soil investigations and furnishing bore log data at various tower locations. Based on the bore log data / soil parameter /soil investigation results, the Contractor shall recommend the type of foundations suitable for each locations and the same shall be approved by the Employer.

6.3.2.2. These specifications cover the technical requirements for a detailed geotechnical investigation and submission of a detailed geotechnical report. The work shall include mobilization of all necessary tools and equipment, provision of necessary engineering supervision and technical personnel, skilled and unskilled labour, etc. as required carrying out the entire field investigation as well as laboratory tests, analysis and interpretation of data collected and preparation of the geotechnical report. The Contractor shall also collect data regarding variation of subsoil water table along the proposed line route. Detailed methodology for subsoil investigation shall be submitted before implementing the subsoil investigation. All laboratory tests shall be done at the test facility approved by the Employer. The Contractor may appoint a Subcontractor to carry out the site geotechnical investigation, but aforementioned works shall be supervised by a Contractor's Engineer who has a bachelor's degree in civil engineering and at least 5 years of site experience in geotechnical investigation work. All work and all lab work shall be witnessed by the above mentioned Contractor's Engineer who shall countersign all recorded data.

6.3.2.3. The Contractor shall make his own arrangements to establish the coordinate system required to position boreholes, tests pits and other field test locations as per the drawings/sketches supplied by Employer. The Contractor shall determine the reduced levels at these locations with respect to benchmarks used in the detailed survey. Two reference benchmarks shall be established based on survey data/details. The Contractor shall provide at site all required survey instruments to the satisfactions of the Employer so that the work can be carried out accurately according to specifications and drawings. The Contractor shall arrange to collect the data regarding change of course of rivers,

major natural streams and nalas (canals), etc., encountered along the transmission line route from the best available sources and shall furnish complete hydrological details including maximum velocity discharge, silt factor, highest flood level (H.F.L), scour depth etc. of the concerned rivers, major streams and nalas.

6.3.2.4. The field and laboratory data shall be recorded in the formats recommended per relevant Standards. The Contractor shall submit to Employer two copies of field bore logs (one copy each to Employer project and Head Office) and all the field records (witnessed & countersigned by the Employer) soon after the completion of each boreholes/test.

6.3.2.5. Whenever the Contractor is unable to extract undisturbed samples, he shall immediately inform the Employer. Special care shall be givento locations where marshy soils are encountered and the Contractor in such cases shall ensure that the specified numbers of vane shear tests are performed and the results correlated with other soil parameters.

6.3.2.6. The Contractor shall interact with the Employer to get acquainted with the different types of structures envisaged and in assessing the load intensities on the foundation for the various types of towers in order to enable him to make specific recommendation for the depth, founding strata, type of foundation and the allowable bearing pressure.

6.3.2.7. After reviewing the Contractor's geotechnical investigation draft report, the Employer will call for discussions, to be held normally within one week, in order to comment on the report in the presence of Contractor's Geotechnical Engineer. Any expenditure associated with the redrafting and finalizing the report, traveling etc. shall be deemed included in the rates quoted for the geotechnical investigations.

6.3.2.8. The Contractor shall carry out all work expressed and implied in these specifications in accordance with the requirements of the specification.

6.3.2.9. The Contractor shall prepare and submit soil profiles along the transmission line route (in digitized form, with digitized route alignment drawing as base) indicating salient soil characteristics / features, water table, etc. based on detailed soil investigations and other details / information collected during detailed survey.

6.3.3 General Requirements

6.3.3.1. Wherever possible, the Contractor shall research and review existing local knowledge, records of test pits, boreholes, etc., types of foundations adopted and the behaviour of existing structures, particularly those similar to the present project.

6.3.3.2. The Contractor shall make use of information gathered from nearby quarries, unlined wells excavation etc. Study of the general topography of the surrounding areas will often help in the delineation of different soil types.

6.3.3.3. The Contractor shall gather data regarding the removal of overburden in the project area either by performing test excavations, or by observing soil erosion or landslides in order to estimate reconsolidation of the soil strata. Similarly, data regarding recent landfills shall be studied to determine the characteristic of such landfills as well as the original soil strata.

6.3.3.4. The water level in neighbouring streams and water courses shall be noted. The Contractor shall make enquiries and shall verify whether there are abandoned underground works e.g. worked out ballast pits, quarries, old brick fields, mines, mineral workings etc.

6.3.3.5. It is essential that equipment and instruments be properly calibrated at the commencement of the work. If the Employer so desires, the Contractor shall arrange for having the instruments tested at an approved laboratory at its cost and shall submit the test reports to the Employer. If the Employer desires to witness such tests, the Contractor shall arrange for the same.

6.4 Field Investigation for Soils

Tentative numbers of detailed soil investigation to be done are given in the price schedule of this bidding documents.

6.4.1 Boring

Boreholes are required for detailed soil investigations.

6.4.1.1 General Requirements

6.4.1.1.1. Boreholes shall be made to obtain information about the subsoil profile, its nature and strength and to collect soil samples for strata identification and for conducting laboratory tests. The minimum diameter of the borehole shall be 100mm and boring shall be carried out in accordance with the provisions of BS 5930 and the present specification:

6.4.1.1.2. All boreholes shall be at least 30m deep for normal soil conditions. The depth of boreholes at river crossings and special locations shall be at least 60m. If a strata is encountered where the standard penetration test records N values higher than 50, the borehole shall be advanced by coring at least 3 m further in normal locations and at least 6 m further for the case of river crossing locations with prior approval of the Employer. When the boreholes are to be terminated in soil strata, an additional standard penetration test shall be carried out at the termination depth. No extra payment shall be made for carrying out standard penetration tests.

6.4.1.1.3. Casing pipe shall be used when collapse of a borehole wall is probable. The bottom of the casing pipe shall at all times be above the test of sampling level but not more than 15 cm above the borehole bottom. In case of cohesion-less soils, the advancement of the casing pipe shall be such that it does not disturb the soil to be tested or sampled. The casing shall preferably be advanced by slowly rotating the casing pipe and not by driving.

6.4.1.1.4. In-situ tests shall be conducted and undisturbed samples shall be obtained in the boreholes at intervals specified hereafter. Representative disturbed samples shall be preserved for conducting various identification tests in the laboratory. Water table in the bore hole shall be carefully recorded and reported following BS 5930. No water or drilling mud shall be used while boring above ground water table. For cohesion less soil below water table, the water level in the borehole shall at all times be maintained slightly above the water table.

6.4.1.1.5. The borehole shall be cleaned using suitable tools to the depth of testing or sampling, ensuring least or minimum disturbance of the soil at the bottom of the borehole. The process of jetting through an open tube sampler shall not be permitted. In cohesive soils, the borehole may be cleaned by using a bailer with a flap valve. Gentle circulation of drilling fluid shall be done when rotary mud circulation boring is adopted.

6.4.1.1.6. On completion of the drilling, the Contractor shall backfill all boreholes as directed by the Employer.

6.4.1.2 Auger Boring

Auger boring may be employed in soft to stiff cohesive soils above the water table. Augers shall be of helical or post hole type and the cuttings brought up by the auger shall be carefully examined in the field and the description of all strata shall be duly recorded in the field bore log as per BS 5930. No water shall be introduced from the top while conducting auger boring.

6.4.1.3 Shell and Auger Boring

Shell and auger boring may be used in all types of soil which are free from boulders. For cohesion less soil below ground water table, the water level in the borehole shall always be maintained at or above ground water level. The use of chisel bits shall be permitted in hard strata having SPT-N value greater than 50 Chisel bits may also be used to extend the bore hole through local obstructions such as old construction, boulders, rocky formations, etc.

The rotary method may be used in all types of soil below water table. In this method, the boring is carried out by rotating the bit fixed at the lower end of the drill rod. Proper care shall be taken to maintain firm contact between the bit and the bottom of the borehole. Bentonite or drilling mud shall be used as drilling fluid to stabilize and protect the inside surface of the borehole. Use of percussion tools shall be permitted in hard clays and in dense sandy deposits.

6.4.2 Standard Penetration Test (SPT)

6.4.2.1 This test shall be conducted in all types of soil deposits encountered within a borehole, to find the variation in the soil stratification by correlating with the number of blows required for unit penetration of a standard penetrometer. Structure sensitive engineering properties of cohesive soils and sifts such as strength and compressibility shall not be inferred based on SPT values.

6.4.2.2 The test shall be conducted at the following depths:

Location	Test Depths (m)
Normal soils for open cast foundations	**2.0, 3.0, 5.0, 7.0, 10.0**
Pile foundation locations & special locations.	**Each level at an interval of 1.5m depth up to minimum 30 m depth.**

6.4.2.3 The spacing between the levels of standard penetration test and next undisturbed sampling shall not be less than 1.0 m. Equipment, accessories and procedures for conducting the test and for the collection of the disturbed soil samples shall conform to BS 5930 respectively. Blow count for the test shall be started 0.45m before reaching desired test depth and after cleaning of bore hole.

6.4.2.4 The test shall be carried out by driving a standard split spoon sampler in the bore hole by means of a 63.5kg hammer having a free fall of 0.76 m. The sample shall be driven using the hammer for 450 mm recording the bumper of blows for every 150 mm. The number of blow for the last 300 mm drive shall be reported as N value.

6.4.2.5 After 30m, the test shall be discontinued when the blow count is equal to 50. But 2 additional blow count for normal locations and 4 additional blow count for river crossing & special locations at 1.5m

intervals shall be recorded after reaching first blow count of 50. At the level where the test is discontinued, the number of blows and the corresponding penetration shall be reported. Sufficient quantity of disturbed soil samples shall be collected from the split spoon sampler for identification and laboratory testing. The sample shall be visually classified and recorded at the site as well as properly preserved without loss of moisture content and labelled.

6.4.3 Sampling

6.4.3.1 General

6.4.3.1.1 Sufficient number of soil samples shall be collected. Disturbed soil samples shall be collected for soil identification and for conducting tests such as sieve analysis, index properties, specific gravity, chemical analysis etc. Undisturbed samples shall be collected to estimate the physical bearing capacity and settlement properties of the soil.

6.4.3.1.2 All accessories and sampling methods shall conform to BS 5930: all disturbed and undisturbed samples collected in the field shall be classified at site as per BS 5930.

6.4.3.1.3 All samples shall be identified with date, borehole or test pit number, depth of sampling, etc. The top surface of the sample in-situ shall also be marked. Care shall be taken to keep the core and box samples vertical, with the mark directing upwards. The tube samples shall be properly trimmed at one end and suitably capped and sealed with molten paraffin wax. The Contractor shall be responsible for packing, storing in a cool place and transporting all the samples from site to the laboratory within seven days after sampling with probe, protection against loss and damage.

6.4.3.2 Disturbed Samples

6.4.3.2.1 Disturbed soil samples shall be collected in boreholes at regular intervals. Samples shall be collected at the same level of the SPT implemented and at every identifiable change of strata to supplement the boring records. Samples shall be stored immediately in air tight jars which shall be filled to capacity as much as possible.

6.4.3.2.2 In designated borrow areas, bulk samples, from a depth of about 0.5 m below ground level shall be collected to establish the required properties for use as a fill material. Disturbed samples weighing about 25 kg (250 N) shall be collected at shallow depths and immediately stored in polythene bags as per BS 5930. The bags shall be sealed properly to preserve the natural moisture content of the sample and placed in wooden boxes for transportation.

6.4.3.3 Undisturbed Samples

In each borehole, undisturbed samples shall be collected at every change of strata and at depths as follows:

Location	Depths (m)
Normal Soils for open cast foundations	1.0, 4.0, 6.0, 8.0, 10.0 m
Pile foundation locations & special locations	1.0, 4.0, 6.0, 8.0,11.0 and thereafter at the rate of 3 m intervals up to 30 m

The spacing between the top levels of undisturbed sampling and standard penetration testing shall not be less than 1.0 m. Undisturbed samples shall be of 100mm diameter and 450mm in length. Samples shall be collected in a manner to preserve the structure and moisture content of the soil Accessories and sampling procedures shall conform to BS 5930.

a) Undisturbed sampling in cohesive soil:

Undisturbed samples in soft to stiff cohesive soils shall be obtained using a thin walled sampler. In order to reduce the wall friction, suitable precautions, such as oiling the surfaces shall be taken.

b) Undisturbed sampling in very loose, saturated, sandy and silky soils and very soft clays:

Samples shall be obtained using a piston sampler consisting of a cylinder and piston system. In soft clays and silky clays, with water standing in the casing pipe, piston sampler shall be used to collect undisturbed samples in the presence of expert supervision.

Accurate measurements of the sampling depth, dimensions of sampler, stroke and length of sample recovery shall be recorded. After the sampler is pushed to the required depth, the cylinder and piston system shall be drawn up together, preventing disturbance and changes in moisture content of the sample.

c) Undisturbed sampling in cohesion less soils

Undisturbed samples in cohesion less soils shall be obtained in accordance with BS 5930. Sampler operated by compressed air shall be used to sample cohesion less soils below ground water table.

6.4.4 Ground Water

One of the following methods shall be adopted for determining the elevation of ground water table in boreholes as per relevant BS standard and the instructions of the Employer:

- In permeable soils, the water level in the borehole shall be allowed to stabilize after depressing it adequately by bailing before recording its level. Stability of sides and bottom of the boreholes shall be ensured at all times.
- For both permeable and impermeable soils, the following method shall be suitable. The borehole shall be filled with water and then bailed out to various depths. Observations on the rise or fall of water level shall be made at each depth. The level at which neither fall nor rise is observed shall be considered the water table elevation and confirmed by three successive readings of water level taken at two hours interval.

If any variation of the ground water level is observed in any specific boreholes, the water level in these boreholes shall be recorded during the course of the filed investigation. Levels in nearby wells, streams, etc., if any, shall also be noted in parallel.

Subsoil Water Samples

- Subsoil water samples shall be collected for performing chemical analysis. Representative ground water samples shall be collected when first encountered in boreholes and before the addition of water to aid boring or drilling.
- Chemical analysis of water samples shall include determination of pH value, turbidity, sulphate and chloride contents, presence of organic matter and suspended solids. Chemical preservatives may be added to the sample for cases as specified in the test methods.

6.4.5 Vane Shear Test (Required for Boreholes where Undisturbed Sampling is not possible - Only at Special Locations)

Field vane shear test shall be performed inside the borehole to determine the shear strength and bearing capacity of cohesive soils, especially of soft and sensitive clays, which are highly susceptible to sampling disturbance. Equipment, accessories, test procedures, field observations shall correspond to BS 5930. Tests may also be conducted by direct penetration from ground surface. If the cuttings at the test depth in the borehole show any presence of gravel, sand shells, decomposed wood, etc., which is likely to influence the test results substantially, the test at that particular depth may be omitted with the permission of the Employer. However, the test shall be conducted at a depth where these obstructions cease to occur. On completion of the test, the results shall be reported as specified in BS 5930.

6.5 Laboratory Testing

6.5.1 Essential Requirements

6.5.1.1. Depending on the types of substrata encountered, appropriate laboratory tests shall be conducted on soil and rock samples collected in the field. Laboratory tests shall be scheduled and performed by qualified and experienced personnel who are thoroughly conversant with the work. Tests indicated in the schedule of items shall be performed on soil, water and rock samples as per relevant British codes or the equivalent codes approved by the Employer. One copy of all laboratory test data records shall be submitted to Employer. Laboratory tests shall be carried out concurrently with the field investigations as initial laboratory test results could be useful in planning the later stages of field work. A schedule of laboratory tests shall be established by Contractor to the satisfaction of the Employer within one week of completion of the first borehole;

6.5.1.2. Laboratory tests shall be conducted using approved apparatus complying with the requirements and specification of BS 1377 or other approved standards for this type of work. It shall be checked that the apparatus are in good working condition before starting the laboratory tests. Calibration of all the instruments and their accessories shall be done carefully and precisely at an approved laboratory;

6.5.1.3. All samples, whether undisturbed or disturbed shall be extracted, prepared and examined by competent personnel properly trained and experienced in soil sampling. examination, testing and in using the apparatus in conformance with the specified standards;

6.5.1.4. Undisturbed soil samples retained in liners or seamless tube samplers shall be removed, without causing any disturbance to the samples, using suitably designed extruders just prior to actual testing. If the extruder is horizontal, proper support shall be provided to prevent the sample from breaking. For screw tube extruders, the pushing head shall be free from the screw shaft so that no torque is applied to the soil sample in contact with the pushing head. For soft clay samples, the sample tube shall be cut by means of a high speed hacksaw to proper test length and placed over the mould before pushing the sample into it with a suitable piston;

6.5.1.5. While extracting a sample from a liner or tube, care shall be taken to assure that its direction of movement is the same as that during sampling to avoid stress reversal.

6.5.2 Tests

Tests as indicated in these specifications and as may be requested by the Employer, shall be conducted. These tests shall include but may not be limited to the following:

a. Tests of undisturbed and disturbed samples
   - Visual and engineering classification;
   - Sieve analysis and hydrometric analysis;
   - Liquid, plastic and shrinkage limits;
   - Specific gravity.

b. Tests of undisturbed samples:
   - Bulk density and moisture content;
   - Relative density(for sand);
   - Unconfined compression test;
   - Direct shear test or Tri-axial shear tests (depending on the type of soil and field conditions on undisturbed or remoulded samples):
     - Unconsolidated untrained;
     - Consolidated drained test;

c. Chemical analysis of sub soil water.

6.5.3 Salient Test Requirement

Tri-axial shear tests shall be conducted on undisturbed soil samples, saturated by the application of back pressure. Only if the water table is at sufficient depth so that chances of its rising to the base of the footing are small or nil, the tri-axial tests shall be performed on specimens at natural moisture content. Each test shall be carried out on a set of three test specimens from one sample at cell pressures equal to 100, 200 and 300 KPa respectively or as required depending on the soil conditions;

Direct shear test shall be conducted on undisturbed soil samples. The three normal vertical stresses for each test shall be 100, 200 and 300 KPa or as required for the soil conditions.

6.6 Test Level

6.6.1 Level 1

Level 1 geotechnical investigation shall be based on a visual-tactile examination of disturbed soil samples for the determination of both soil classification and strength. Visual-tactile examination shall be undertaken in accordance with the recommendations of ASTM D2488. Samples shall be taken from either trial pits, bore holes, hand held augers, or if specified during course of the foundation excavation.

Where dynamic probing is used in conjunction with a higher level geotechnical investigation technique, the probe shall be calibrated to the satisfaction of the Engineer against the results of the higher level tests. Details of the Contractor's calibration proposals and calibration results shall be submitted to the Engineer. **This is a Hold Point.**

6.6.2 Level 2

6.6.2.1 Level 2 geotechnical investigation shall be based on in-situ testing for the determination of the soil strength and laboratory tests of disturbed samples for the determination of soil classification such as particle size distribution, Atterberg limits. For details of the soil classification reference should be made to **Annex 6-3**.

6.6.2.2 In-situ testing, shall comply with the following requirements:

a. Non-cohesive soil - standard penetration tests (SPTs), cone penetration tests (CPTs), or in the absences of large gravel content pressure meter tests (PMTs);
b. Cohesive soil - As for non-cohesive soils except that use of SPTs is subject to the Engineer's approval. Vane shear tests (VSTS) may also be used in fairly uniform fully saturated soils;
c. Rock - Weak rock SPTs, medium to hard rock PMTs.

6.6.2.3 Where it is proposed to determine the soil classification indirectly from the in-situ tests e.g. CPTs, cross correlation shall be undertaken at specified intervals using auger borings.

6.6.2.4 Laboratory soil classification tests for non-cohesive soils shall be particle size distribution, moisture content and relative density, whilst those for cohesive soils shall be moisture content and Atterberg limits. Whilst strength tests shall be direct shear box (immediate) and bulk density for non-cohesive soils and unconfined compressive strength, direct shear box (immediate) and bulk, density for cohesive soils. All laboratory testing shall be undertaken in accordance with BS 1377.

6.6.2.4 Where appropriate ground water levels shall be recorded in all boreholes.

6.6.3 Level 3

Level 3 geotechnical investigation shall be based on in-situ testing (as for Level 2) for the determination of the soil strength and the recovery of disturbed soil samples for subsequent laboratory testing.

Laboratory soil classification tests for non-cohesive soils shall be particle size distribution, moisture content and relative density, whilst those for cohesive soils shall be moisture content and Atterberg limits. Whilst strength tests shall be direct shear box (immediate) and bulk density for non-cohesive soils and unconfined compressive strength, laboratory vane shear and bulk, density for cohesive soils. All laboratory testing shall be undertaken in accordance with BS 1377.

6.6.4 Level 4

Level 4 geotechnical investigation shall be based on a combination of in-situ testing (as for level 2) and recovery of disturbed/undisturbed soil samples for subsequent laboratory testing.

Laboratory soil classification tests shall be as per Level 3, whilst strength tests shall be direct shear and bulk density for cohesive soils and unconfined compressive strength, laboratory vane shear, tri-axial compression (undrained) as appropriate and bulk density for Non-cohesive soils. All laboratory testing shall be undertaken in accordance with BS 1377.

6.7 Geotechnical Investigation Report

6.7.1 General

6.7.1.1 The Contractor shall submit a formal report containing geological information of the region, procedures adopted for geotechnical investigation, field observations, summarized test data, conclusions and recommendations. The report shall also include detailed bore logs, subsoil sections, field test results, laboratory observations and test results both in tabular as well as graphical form, practical and theoretical considerations for the interpretation of test results, supporting calculations for the conclusions drawn, etc. Initially, the Contractor shall submit three copies of the report in draft form for Employer's review;

6.7.1.2 The Contractor's Geotechnical Engineer shall visit Employer's Corporate/main site Office for a detailed review based on Employer's comments in order to discuss the nature of modifications, if any, to be done in the draft report. The Contractor shall incorporate in the report the agreed modifications. Three copies of the detailed final approved report shall be submitted to Employer together with one set of reproducible of the graphs, tables, etc.;

6.7.1.3 The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical considerations for foundations for different types of structures.

6.7.2 Data to be Furnished

The report shall also include the following:

a. A plot plan/location plan showing the locations and reduced levels of all field test e.g. boreholes, trial pits, static cone penetration tests, dynamic cone penetration tests, etc., property drawn to scale and dimensioned with reference to the established grid lines;
b. A true cross section of all individual boreholes and test pits with reduced levels and coordinates showing the classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted, samples collected at different depths and the rock stratum, if encountered;
c. Geological information of the area including geomorphology, geological structure, etc.
d. Past observations and historical data, if available, for the area or for other areas with similar soil profile, or with similar structures in the surrounding areas;
e. Plot of Standard Penetration Test (uncorrected and corrected N values) with depth for each test site;
f. Results of all laboratory test summarised according to Table 1 (i) for each sample as well as (ii) for each layer, along with all the relevant charts, tables, graphs, figures, supporting calculations;
g. For all triaxial shear tests, stress vs. strain diagrams as well as Mohr's circle envelopes shall be furnished. If back pressure is applied for saturation, the magnitude of the same shall be indicated. The value of modulus of elasticity (E) shall be furnished for all tests along with relevant calculations.

Table 6-1: Summary of Results of Laboratory Tests on Soil and Water Samples

Description	Results
1. Bore hole test pit. no	
2. Depth (m)	
3. Type of sample	
4. Density (kg/m³)	
a) Bulk	
b) Dry	
c) Submerged	
5. Water content (%)	
6. Particle Size (%)	
a) Gravel	
b) Sand	
c) Silt	
d) Clay	
7. Consistency properties	
a) LL	
b) PL	
c) PI	
d) LI	
8. Soil	
a) Classification	
b) Description	
c) Specific gravity	
9. Strength Test	
a) Type	
b) C (Cohesion)	
c) Ø (angle of internal friction)	
d) Angle of repose	
10. Shrinkage limit (%)	
11. Relative Density (%)	
12. Remarks	

Notations:

For type of sample:

- DB - Disturbed bulk soil sample;
- DP - Disturbed SPT soil sample;
- DS - Disturbed samples from cutting edge of undisturbed soil sample.
- RM - Remoulded soil sample;
- UB - Undisturbed block soil sample;
- US - Undisturbed soil sample by sampler;
- W - Water sample.

For strength test:

- SCPT - Static Cone Penetration Test;
- UCC - Unconfined Compression Test;
- VST - Vane Shear Test;
- Tuu - Unconsolidated UndrainedTriaxial Test.
- Note: Replace T by D for Direct Shear Test
- Tod - Consolidation Drained Triaxial Test.

For others:

- LL - Liquid Limit (%);
- PL - Plastic Limit;
- PI - Plasticity Index;
- LI - Liquidity Index;
- C - Cohesion (kPa);
- Ø - Angle of Internal Friction (degrees);
- S-Pr. - Swelling Pressure (kPa);
- e_0 - Initial Void Ratio;
- P_c - Reconsolidation Pressure (kPa);
- C_c - Compression Index;
- DP - Change in Pressure (kPa);
- m_v - Coefficient of Volume Compressibility (m^2/KN);
- C_v - Coefficient of Consolidation (m^2/hr).

For chemical test:

- As per specifications - see Clause **6.7.4.**

6.7.3 Recommendations

Recommendations shall be provided for each tower location duly considering soil type and tower spotting data. The recommendations shall provide all design parameters and considerations required for proper selection, dimensioning and future performance of tower foundations and the following:

a. The subsurface material must provide safe bearing capacity and uplift resistance by incorporating appropriate safety factors thereby avoiding rupture under ultimate loads;

b. Movement of the foundation, including short and long term components under transient and permanent loading, shall be strictly controlled with regard to settlement, uplift, lateral translation and rotation:

c. Core resistance, frictional resistance total resistance, relation between core resistance, standard penetration test N value.

d. For shallow foundation the following shall be indicated with comprehensive supporting calculations:

e. Net safe allowable bearing pressure for isolated square footing of sizes 4.0, 5.0, 6.0 & 7.0 m at three different founding depths of 2 and 3 & 3.5 m below ground level considering both shear failure and settlement criteria giving reasons for type of shear failure adopted in the calculation.
    - Net safe allowable bearing pressure for raft foundations of widths greater than 5m at 2.0, 3.0 and 4.0 m below ground level considering both shear failure and settlement criteria.
    - Rate and magnitude of settlement expected of the structure.
    - Net safe bearing capacity for foundation sizes mentioned in para(i) above, modulus of sub grade reaction, modules of elasticity from plate load test results along with time settlement curves and load settlement curve in both natural and log graph, variation of Modulus of sub grade reaction with size, shape and depth of foundation.

f. The stable slopes for shallow and deep excavations, active and passive earth pressure at rest and angle of repose for sandy soils shall be furnished. The loading of the foundations shall not compromise the stability of the surrounding subsurface materials and the stability of the foundation shall be ensured against sliding or overturning;

g. Depending on the subsurface material, water table level and tower type, either reinforced concrete isolated pad and chimney, cast-in-situ bored pile of special foundations shall be installed at a given location;

h. Net Safe allowable bearing pressure and uplift resistance shall be provided for the various sizes of isolated square footings founded at various depths below ground level considering both shear failure and movement criteria; rate and magnitude of movement expected of the structure (settlement, uplift, rotation) shall also be given;

i. In cases where normal open cast/pile foundations appear to be impractical, special pile foundations shall be given due consideration along with the following:
   - Type of pile foundation and reasons for recommending the same duly considering the soil characteristics;
   - Suitable founding strata for the pile;
   - Estimated length of pile for 500, 750, 1000 KN and 4500 KN capacities end bearing and frictional resistance shall be indicated separately;
   - Magnitude of negative skin friction or uplift forces due to soil swelling.

j. Where the subsoil water and soil properties are found to be chemically aggressive. The Contractor shall take suitable precautions during construction including any protective coating to be applied on the foundations; susceptibility of soil to termite action and remedial measures for the same shall be dealt with;

k. Suitability of locally available soils at site for filling, backfilling and adequate compaction shall be investigated;

l. If expansive soil such as black cotton soil is encountered recommendation of removal or retainment of the same shall be given in the latter case, detailed specifications of special requirements shall also be given;

m. Susceptibility of subsoil strata to liquefaction in the event of earthquake and remedial measures, if required, shall be considered;

n. Any other information of special significance such as dewatering schemes, etc. which may have a bearing on the design and construction shall be provided;

o. Recommendations for additional soil investigations, beyond the scope of the present work, shall be given if Contractor considers such investigations necessary.

6.7.4 Hydro-geological Conditions

The maximum elevation of ground water table, amplitudes of its fluctuations and data on water aggressively with regard to foundation structure materials shall be reported. While preparing ground water characteristics the following parameters should be specified for each aquifer:

a. bicarbonate alkalinity, mg-eq/(deg.);
b. pH value;

c. content of aggressive carbon dioxide, mg/l;
d. content of magnesia salts. mg/l, recalculated in terms of ions, Mg+2;
e. content of ammonia salts, mg/l, recalculated in terms of ions, NH4+;
f. content of caustic alkalis, mg/l, recalculated in terms of ions, Na+ and K+;
g. contents of chlorides, mg/l recalculated in terms of ions,Cl-;
h. contents of sulphates, mg/l, recalculated in terms of ions, SO4-2;
i. aggregate content of chlorides, sulphates, nitrates, carbonates and other salts, mg/l.

6.8 Morphological Study of Rivers

Morphological study should be conducted for the rivers which are crossed by transmission line or the rivers that run parallel/close to transmission line. The study shall be carried out by a specialist firm/person appointed by the Contractor in consultation with the Employer's Engineer. Duely sealed and signed study report shall be submitted by the Contractor for Employer's review and approval.

The study report shall include the following:

a. Geological information of the study area including geomorphology, geological structure.
b. Observations and data regarding historical channel and bank line movement for the river/ change of course of river;
c. Prediction about possible future development of the river.
d. Design discharge, maximum velocity, scour depths, slit factor, etc., and history of flood details for mid-stream and river bank locations.
e. Study area should cover at least 2 km in upstream and 2 km in downstream from the proposed transmission line.
f. Reduced level (RL) of existing ground, highest water level and maximum scour depth for every tower location should be mentioned with respect to Mean Sea Level (MSL).
g. Any other relevant data if necessary for design and execution of tower foundation should be included in the study report.
h. Past observations and historical data, if available, for the area or for other areas with similar soil profile, or with similar structures in the surrounding areas.

6.9 Rates and Measurements

6.9.1 Rates

The Contractor's quoted rates shall be inclusive of making observations, establishing the ground level and coordinates at the location of each borehole, test pit etc. No extra payments shall be made for standard penetration test, collecting, packing, transporting of all samples and cores, recording and submittal of results on approved formats and conducting morphological study of rivers.

6.10 Field Quality Plan

A standard field quality plan is given in **Annex 3-5** of this document as a minimum requirement. Bidders are requested to convey their acceptance of the same along with their offer.

6.11 Foundation Setting Level Diagrams

Where specified foundation setting level diagrams shall be prepared for specific tower positions. At a scale of 1:200 (horizontally and vertically) the foundation excavation and setting levels on the two diagonals (drawn separately) shall be shown, together with a record of the applicable foundation design, leg and body extensions and tower centre-peg coordinates.

Annex 6-1: Crossing of Obstacles

Annex 6-1(1): Basic External Clearance

The minimum clearances defined below shall not be infringed at the specified maximum operating temperature of the phase conductor with the suspension insulators hanging vertically or deflected to any angle up to 70° from the vertical.

Nominal system voltage	**(kV)**	**132**		**230**		**400**	
	Conductor	**ACSR/ AAAC**	**ACCC**	**ACSR/ AAAC**	**ACCC**	**ACSR/ AAAC**	**ACCC**
Maximum conductor temperature	(°C)	80	180	80	180	80	180
Maximum earthwire/OPGW temperature	(°C)	50	50	50	50	50	50

Description of Clearance - Minimum Clearance

Description	**Unit**	**132kV**	**230kV**	**400kV**
Ground (see note d)	(m)	7.0	8.0	9.0
Roads	(m)	8.0	9.0	14.0
Buildings, structures, walls or other objects on which a person can stand or against which he can lean a ladder (see note b)	(m)	5.0	7.0	8.0
Trees (see note c)	(m)	3.5	5.5	6.5
Shrubs	(m)	3.0	5.5	6.5
Railways (measured from railway track)	(m)	15.6	18.26	18.5
River Crossing	(m)	23.0	25.0	26.0

Notes:

a. Clearances are measured to the nearest projection of an object.

b. These clearances also apply to earthed metalclad buildings.

c. Clearances applicable to trees under the transmission line and to trees adjacent to the line. Clearances also applicable to trees falling, towards the line with conductors hanging in a vertical plane.

d. The clearance shall be measured from the highest flood level or from the ground level whichever is higher.

Annex 6-1(2): Clearance from Electric Lines

Where a transmission line crosses above or below another transmission line, the following clearances shall be obtained.

In still air, and with the phase conductor temperature of the lower transmission line at 5°C whilst the assumed phase conductor temperature of the higher transmission line is at its maximum operating temperature, the following minimum clearances between the lowest conductor (phase or earth) of the higher transmission line and the highest conductor (phase or earth) of the lower line are applicable:

Sl. No.	Nominal System Voltage	132kV	230kV	400kV
1.	132 kV	4	5.5	7
2.	230 kV	5.5	5.5	7
3.	400 kV	7	7	9

Notes:

i) The voltage specified is that for which transmission lines are ultimately designed to operate.
ii) Clearances are determined by the ultimate voltage of either the upper or lower transmission line, whichever is the greater.
iii) Clearances are determined by the ultimate voltage of the upper/lower transmission line.

In addition to the above at the point of crossing, the clearance in (a) shall be obtained assuming the conductors of the lower transmission may swing up to 45° from the vertical.

Crossings of power supply and communication circuits shall not be at angle to the normal greater than 45 degrees without previous agreement of the Engineer.

Annex 6-1(3): Crossing of Pipelines

Pipeline crossings shall not be at angle to the normal greater than 20 degrees.

Annex 6-2: Geotechnical Investigation

Geotechnical Investigation Level - Frequency

Level 2 Every tower site excluding river crossing and anchor towers and rigid frame tower.
Level 4 At river crossing, anchor towers and rigid frame tower.

Ground water samples shall be taken at every tension tower and all river crossing, anchor tower positions for chemical analysis.

Annex 6-3: Soil Classification by United Soil Classification System

Major Divisions (1)	Subdivisions (2)	USCS Symbol (3)	Typical names (4)	Laboratory classification criteria (5)	
Coarse-grained soils (more than 50% retained on no. 200 sieve)	Gravels (more than 50% of coarse fraction retained on no.4 sieve)	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.	Less than 5% fines.	CU≥4 and 1≤ CC≤3
		GP	Poorly graded gravels or gravelly sands, little or no fines.	Less than 5% fines.	Does not meet CU and/or CC criteria listed above.
		GM	Silty gravels, gravel-sand-clay mixtures.	Less than 12% fines.	Minus No. 40 soil plots below the A-line.
		GC	Clayey gravels, gravel-sand-clay mixtures.	Less than 12% fines.	Minus No. 40 soil plots on or above the A-line.
	Sands (50% or more of coarse fraction passesno.4 sieve)	SW	Well-graded sands or gravelly sands, little or no fines.	Less than 5% fines.	CC ≥6 and 1≤ CC ≤3.
		SP	Poorly graded sands or gravelly sands, little or no fines.	Less than 5% fines.	Does not meet CU and/or CC criteria listed above.
		SM	Silty sands, sand-silt mixtures.	Less than 12% fines.	Minus No. 40 soil plots below the A-line.
		SC	Clayey sands, sand-clay mixtures.	Less than 12% fines.	Minus No. 40 soil plots on or above the A-line.
Fine-grained soils (50% or more passes the no. 200 sieve)	Silts and clays (liquid limit less than 50)	ML	Inorganic silts, rock flour, silts of low plasticity	Inorganic soil	PI＜4 or plots below A-line
		CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, etc.	Inorganic soil	PI＞7and plots on or above A-line
		OL	Organic silts and organic clays of low plasticity	Organic soil	LL (oven dried)/LL (not dried)＜0.75
	Silts and clays (liquid limit 50 or more)	MH	Inorganic silts, micaceous silts, silts of high plasticity	Inorganic soil	Plots below A-line
		CH	Inorganic highly plastic clays, fat clays, silty clays, etc.	Inorganic soil	Plots on or above A-line
		OH	Organic silts and organic clays of high plasticity	Organic soil	LL(oven dried)/LL(not dried)＜0.75
Peat	Highly organic	PT	Peat and other highly organic soils	Primarily organic matter, dark in colour, and organic odour	

** If 4≤ PI≤7 and PI plots above A-line, then dual symbols (e.g. CL-ML) are required.

Annex 6-4: Engineering Documents to be Submitted by the Contractor

Clause Reference	Document Description	Comment
6.2.6	Route map, Mouza map and profile drawings	
6.3.1	Slope stability analysis	if specified
6.6.1	Dynamic probe	calibration details
6.7	Geotechnical investigation	test results

Annex 6-5: Notification and Hold Points

Clause Reference	Notification Points	Hold Points
6.1		Survey
6.2.6		Route maps, Mouza maps and profile drawings
6.3		Geotechnical investigation
6.6.1		Dynamic probe calibration
6.6.1		Level 1

Annex 6-6: Reference Standards

The reference standards and other documents referred to in this Section of the Specification are listed below:

BS 1377:	Method of tests for soils civil engineering purposes
BS 5930:	Code of practice for site investigation
ASTM D2488:	Standard recommended practice for description of soil visual manual procedure

7. Foundations

7.1 7.1 SCOPE

7.1.1 General

The type of foundation to be used at each tower position shall be determined from the results of the geotechnical investigation. The design of the foundation shall be in accordance with the design parameters and associated criteria detailed in this Specification for tender design purposes, but finally in accordance with the parameters of the actual geotechnical investigation.

The Contractor shall ascertain from the geotechnical investigation that the ground conditions are suitable for each foundation. The levels of geotechnical investigation specified are the minimum level required at site. The Contractor shall undertake all necessary geotechnical investigation for the foundation design. Any subsidence or failure, due in the opinion of the Engineer to insufficient care having been taken in either the geotechnical investigation, or installation of the foundations shall be the Contractor's responsibility.

In areas where subsidence is likely to occur the Contractor shall if necessary, carry out modifications to the tower foundations as agreed by the Engineer. Collar or tie beams between the individual footings of a tower shall not be used unless specifically authorized by the Engineer. The Contractor shall not be held responsible for failure of tower and foundations arising from adjacent mineral extraction subsequent to the construction of the transmission line. The Contractor shall, however, be held liable for any lack of foundation or tower stability due to causes other than subsidence due to subsequent mineral extraction.

The Contractor is responsible for obtaining approval from the Engineer and where appropriate statutory regulatory bodies for the type and design of the foundations installed. It should be noted as a general requirement that no site work can commence before such approvals have been obtained. **This is a Hold Point.**

7.1.1.1 The work to be performed under this specification consists of excavation and/or boring in all kinds of soil including weathered rock, fissured rock, hard rock, shale etc., providing and installation of open cast RCC foundation and/or cast-in-situ RCC vertical bored piles of specific diameter, providing all labour, materials, supervision, dewatering, scaffolding, platforms, boring and construction equipments & machineries, tools, tackles and plants, supplies, power, fuel, transportation on land and water, all incidental items not shown or specified but reasonably implied or necessary for successful and timely completion of work including Contractor's supervision in strict accordance with BS 8110 & BS 8004, drawings and specifications. The nature of work shall generally involve construction/installation of open cast foundation and/or cast-in-situ RCC vertical bored piles of specified diameter, pile caps, pedestals, tie beam (if required) etc. as per the Employer’s construction drawings and also co-ordination with tower erection contractor for setting of stubs / fixing of anchor bolts (as the case may be).

7.1.1.2 The setting of stub/fixing of foundation anchor bolts (as indicated in the drawing) shall be the responsibility of the Contractor.

7.1.1.3 The Bidder shall quote based on the provisional Bill of Quantities (BOQ) furnished in the Bid Proposal Sheet (B.P.S). No deviation in this respect will be acceptable and any bid quoted based on different Bill of Quantities shall be liable for rejection. However, the payment will be made as per actual quantity executed as per Employer/Employer’s design & drawing based on the unit rates for items quoted.

7.1.2 Method Statement

The Contractor shall submit to the Engineer a comprehensive method statement giving sequential details of his proposed installation method and include his intended programme. The method statement shall include but not be limited to the following details:

(a) method of excavation. (for all types of foundations) and dealing with water;
(b) method of installation of the pile foundations;
(c) method of installation of rigid frame / river crossing tower foundations,
(d) methods for heating, welding and site bending of reinforcement;
(e) method of placing of concrete;
(f) method of curing and protecting the concrete;
(g) method of backfilling and compacting;
(h) Reinstatement of working areas;
(i) Quality Control procedures;
(j) Site safety procedures.

This is a Hold Point.

7.1.3 Foundation Types and Uses

The foundation shall be of open cast type and / or cast in situ piles. Plain Cement Concrete/Reinforced Cement Concrete footing shall be used for all type of normal towers. All the four footings of the tower and their extensions shall be similar for a particular location, except where soil condition and or water table are different at different legs. The minimum depth of foundation, below ground level shall generally be 3.0 meters. For Hard Rock type and also where specific site conditions / properties demand foundation of different depths (lower or higher), the same shall be adopted. Further, for multi circuit tower foundations, foundation depth shall be 3.5 meters and for river crossing open cast foundations, the foundation depth shall be more than 3.5 meters.

Foundations for towers for different categories of soil conditions shall be selected from the approved types detailed in Appendix 7.A1.

Reinforced concrete pile caps shall be used for all types of piles.

Unless specified to the contrary, foundations for angle/terminal towers shall not have different designs for compression and tension footings, but shall be satisfactory for the most adverse condition of maximum and minimum angles of deviation/entry and with the wind blowing from the most onerous direction.

7.1.4 Classification of Foundations

7.1.4.1 Concrete Pad & Chimney Foundations

This foundation takes the form of a reinforced concrete flat slab surmounted by a chimney. Alternatively, the slab may be replaced by a truncated concrete pyramid surmounted by a chimney.

The foundation designs shall depend upon the type of soil, sub soil water level and the presence of surface water which have been classified as follows (except pile foundations).

7.1.4.1.1 Normal dry

To be used for locations where normal dry cohesive or non-cohesive soils are met. Foundations in areas where temporary surface water encountered from rain runoff or agricultural fields (except paddy fields) shall also be classified as normal dry.

7.1.4.1.2 Sandy Dry Soil

To be used for locations where cohesion less pure sand or sand with clay content less than 10% met in dry condition.

7.1.4.1.3 Wet

To be used for locations:

a) Where sub-soil water is met between 1.5 meters and the depth of foundation below the ground level.
b) Which are in surface water for long period with water penetration not exceeding one meter below the ground level e.g. paddy fields.

7.1.4.1.4 Partially Submerged

To be used at locations where sub-soil water table is met between 0.75 meter and 1.5 metre below the ground level.

7.1.4.1.5 Fully Submerged

To be used at locations where sub-soil water table is met at less than 0.75 meter below the ground level.

7.1.4.1.6 Black Cotton Soil

To be used at locations where soil is clayey type, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement. For designing foundations, for such locations, the soil is considered submerged in nature.

7.1.4.1.7 Fissured – Rock

To be used at locations where decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used for fissured rock locations.

In case of fissured rock locations, where water table is met at 1.5M or more below ground level, wet fissured rock foundations shall be adopted. Where fissured rock is encountered with subsoil water table less than 0.75 meter below ground level, submerged fissured rock foundations shall be adopted. In case of dry locations dry fissured rock foundations shall be adopted.

7.1.4.1.8 Hard Rock

The locations where chiseling, drilling and blasting is required for excavation, Hard rock type foundations are to be used. For these locations rock anchoring is to be provided to resist uplift forces.

7.1.4.1.9 Where soil is of composite in nature, classification of foundation shall be according to the type of soil predominant in the footing.

7.1.4.2 Piled Foundations (Deep Foundation)

Piled shaft foundations shall comprise piles suitably connected below ground level by a concrete cap. The Contractor shall submit his proposed method of installation and Quality Control procedures to the Engineer prior to start of piling works, a detailed description of the equipment, materials and procedures that will be used for the piling work. The description shall include equipment specifications, including catalogue data, manufacturer's published specifications, loading capacities, protective devices and test apparatus, detailed installation procedures test procedures, as well as references concerning previously completed piling work. **This is a Hold Point.**

7.1.4.2.1 Piled foundations shall comprise either:

(a) Multiple Piled Foundations Using Raked Piles

The pile loads shall be determined by the vector summation of the horizontal and vertical components of the total reactions at ground level. One multiple pile foundation shall be constructed for each leg, and since the pile group provides all the lateral stability, no interconnecting ground beam between the legs are required. Raked piles are not to be used where ground settlement is likely to impose unacceptable bending stresses in the piles.

(b) Multiple Piled Foundations Using Vertical Piles

This type of foundation shall be used when ground settlement is likely to impose unacceptable bending stresses on raked piles, or where the type of pile cannot be installed raked. In this case lateral stability shall be provided by the passive resistance of the ground acting on the piles, pile cap and their interconnecting ground beams where present. In addition to the loading derived from the tower, ground beams where appropriate shall be designed to accept a specified wheel load.

Ultimate uplift resistance shall be obtained assuming the actual weight of piles, pile caps etc. plus the guaranteed ultimate uplift resistance of the piles. Allowance shall be made for buoyancy effects. The minimum component of the uplift resistance provided by the dead submerged weight of the piles and pile caps should not be less than the value specified in **Appendix 7.A4**.

Ultimate compressive loads shall include the superimposed weight of soil; pile caps (and tie beams, etc.) multiplied by the dead load factor (as per **Appendix 7.A2**) and shall be obtained by the guaranteed ultimate resistance of the piles.

7.1.4.3 Raft Foundations

Raft foundations for wide based lattice towers shall only be used in areas subject to mining settlement, or very poor ground where piling is not possible.

7.1.4.4 Raised Chimney

Chimney of foundation may be raised at high water level area to keep the steel part of the tower away from water. The top of concrete chimney of the foundation shall be at least 450mm above the highest flood level.

The contractor shall confirm the water level and adjust the foundation setting level to meet the requirement. Such foundation site shall be dewatered by pumping or other approved means during excavation, all other necessary arrangements to perform the foundation work in water-logged condition, concrete works and backfilling works. Those costs shall be deemed to be considered in the Contractor's expense.

If raised chimney is required at any location, stubs required for that raised chimney will have to designed by the contractor subject to approval by the Employer. Such costs shall be deemed to be included in the contract price.

Depending on the highest flood level, raised chimney may vary from 1m to 6m in one meter increment. The Contractor shall submit his proposed method of installation and Q.C. procedures to the Engineer prior to commencing his design. This is a **Hold Point.**

7.1.4.5 Rigid Frame Foundation

Rigid framed foundation, which is adopted at high water level area, shall be consisted of rigid frame and pile.

As for foundation design, foundation shall be designed as a rigid frame to withstand against uplift load, compression load and horizontal load. The Contractor will consider friction between pile and soil against uplift load and against compression load, displacement of pile against horizontal load respectively. Individual footings shall be interconnected by tie beams, which shall be adequate to resist lateral forces and hydrostatic pressure exerted by the flood water. Allowances shall be made in the foundation design for hydrostatic pressure and the effects of seasonal rains, and scour.

In flooding area, the top of chimney concrete of the foundation shall be above the highest flood level. The Contractor shall confirm the water level and adjust the foundation setting level to meet the requirement. Such foundation site shall be dewatered by pumping or other approved means during excavation all other necessary arrangements to perform the foundation work in water logged condition, concrete works and backfilling works. Those costs shall be deemed to be considered in the Contractor's rates.

Depending on the water height, rigid frame foundation may vary from 2m to 6m. The Contractor shall submit his proposed method of installation and Q.C. procedures to the Engineer prior to commencing his design. **This is a Hold Point.**

7.1.4.6 River Crossing Foundations

The location of both river crossing tower and anchor tower should be finalized based on hydro and geo-morphological study of the river. Foundations of both river crossing tower and anchor tower shall be treated as foundations on midstream of river. If any other type of tower/towers is/are require to be spotted near/parallel to any river, then base on morphological study foundation of those tower/towers shall be treated same as described above.

Foundation of these types of tower shall be pile supported. The pile shall be designed considering an unsupported height equal to depth of river bed plus allowance for scour depth. If permanent casing is reuired for pile casting upto any depth, the contractor shall considered its cost within the quoted price. Lacey's formula may be applicable for calculating scour depth. All required data to calculate the scour depth shall be collected and managed by bidder themselves. Skin friction for unsupported height shall be considered zero in calculating the pile capacity in this regard.

Top of chimney of this type of tower shall be at least 450mm above highest flood level. The Contractor has to assess the river erosion and has to perform the foundation works within the quoted price even if the tower location found under water during execution stage.

7.2 DESIGN

7.2.1 General

7.2.1.1 Foundation design shall be done by the Contractor as on the basis of reactions given in the Appendix 8.13 and the criteria mentioned in this section.

During foundation design, the obtained reactions shall be multiplied by the strength factors indicated in **Appendix 7.A2**, and the resultant reactions shall be used for foundation design.

7.2.1.2 Depending on the site conditions other types of foundations shall also be designed and provided by the Employer suitable for Intermediate conditions under the above classifications to effect more economy or to suit specific site conditions encountered.

7.2.1.3 The proposal for these types of foundations shall be submitted by the Contractor based on the detailed soil investigation and duly recommended by Engineer-in-charge.

7.2.1.4 The construction drawings /working drawings of all type of foundations classified as in clause 7.1.4 shall be provided to the contractor progressively during execution stage. The drawings for other foundations designed for specific site conditions shall be provided based on actual site requirements only.

7.2.2 Geotechnical Parameters

The geotechnical parameters for tendering purposes are provided in **Appendix 7.A4**. The Contractor shall however perform the geotechnical investigation during execution of the contract at each location as specified in this bidding document. Foundation designs of different towers locations shall be based on the results of geotechnical investigation done by the Contractor. No extra payment will be made if the actual soil condition is found to be worse than the soil parameter given in **Appendix 7.A4**.

7.2.3 Foundation Structural Design Parameters

Foundation structural design parameters for concrete shall be based upon the recommendations of BS 8110, except otherwise defined in this Specification. For structural design of cast in situ piles, guidelines provided in **Appendix 7.A5** should be followed.

7.2.4 Stubs

7.2.4.1 Reference shall be taken from 'Tower' Section.

7.2.4.3 In addition to stubs of normal length, short stubs may be used, provided that provision is made for the attachment of bolted cleats.

7.2.4.4 Cleats shall be capable of transferring 100 percent of the design uplift working load (not factored load) and 50 percent of the design compression working load (not factored load) for shearing and bonding resistance.

7.2.5 Holding Down Bolts (Not Used)

7.2.6 Concrete Chimneys

7.2.6.1 Reinforced concrete chimneys shall be designed to withstand the maximum resultant horizontal residual shear component, with due allowance given where appropriate to resultant lateral (passive) earth pressure of the backfill (assumed to increase linearly with depth).

7.2.6.2 No allowance shall be made of the nominal strength of concrete in tension and the stub shall not be considered as providing any part of the tensile area of reinforcing steelwork.

7.2.6.3 The top of chimney of tower foundation shall be as per **Appendix 7.A8** to this Section.

7.2.6.4 Foundations for lattice steel tower legs with high hillside shear force, due to certain combinations of unequal leg extensions may however differ from those designed for level ground by the addition of extra reinforcement in the chimney.

7.2.7 Concrete Mix Design

7.2.3.1 The Contractor shall be entirely responsible for the control of the quality of concrete mixed and placed, in the Works. Before the commencement of any concrete work, the Contractor shall submit to the Engineer, a complete specification giving details of the materials used, source of supply, storage and quality control requirements, including preliminary trial mixes and works' tests reports. This is a Hold Point.

7.2.3.2 To ensure the durability of the concrete, the requirements specified in Appendix 7.A6 shall be adhered to with regard to characteristic strength, minimum cement content and maximum free water/cement ratio.

7.2.3.3 Admixture should not be used in concrete mix design.

7.2.8 Concrete Cover

7.2.8.1 All structural steelwork and reinforcing including links and stirrups below ground level shall be completely encased in concrete to ensure a minimum cover as specified in **Appendix 7.A7**. Such cover shall exist from the point of entry into the concrete base to either 450 mm above final ground level, or to the top of the concrete leg extension.

7.2.8.2 All foundation concrete to a point 450 mm above final ground level shall be undertaken at the same time and using the same design mix as the main part of the foundation.

7.2.9 Stability Analysis

7.2.10.1 All foundations on slopes greater than 1:4 shall be checked for stability against rotation where appropriate. Due consideration shall be given to the increased upslope lateral loading of the soil and the decrease in downhill resistance provided by the soil, when compared to foundations installed on level ground.

7.2.10.2 Due consideration shall also be taken of any decrease in the uplift resistance of the foundation. Where appropriate, decrease in soil bearing resistance shall also be considered.

7.2.10.3 Where required by the Engineer the overall long-term stability of the slope, including any proposed slope modifications for constructional purposes e.g. benching shall be considered by an approved geotechnical consultant appointed by the Contractor.

7.2.10 Installation Criteria

The Contractor shall prepare a schedule for construction purposes which clearly indicates the soil class and type of foundation to be installed at each tower site. The schedule shall show the basis for selection, taking into account the following items:

a. The results of the geotechnical investigation;
b. The results of any foundation design test;
c. The design criteria;
d. The results of any stability analysis;
e. The occurrence of stagnant water at tower location;
f. Those areas which due to the aggressiveness of the sub-soil or sub-soil water a greater mass of cement per cubic meter of concrete than that specified is required.

The schedule shall be submitted to the Engineer, prior to any foundation installation commencing.

The Contractor must have the facilities to carry on construction of foundation work during rainy season and if the tower is placed at water clogged area. The Contractor is advised to assess the route of the transmission line prior to bidding. Neither time extension nor costs compensation shall be provided in this regard.

This is a Hold Point.

7.2.11 Design Submission

The Contractor shall submit the followings to the Engineer:

a. Signed foundation design calculations along with all soft (software) copies;
b. Foundation general arrangement drawing,
c. Slope stability analysis;
d. Bar bending schedule (information only) - if appropriate;
e. Foundation formwork drawings (information only) - if appropriate;
f. Foundation setting template.

This is a Hold Point.

7.3 CONSTRUCTION OF TOWER FOUNDATION, STUB SETTING AND EARTHING

7.3.1 Open cast foundation

7.3.1.1 Excavation

7.3.1.1.1 The excavation work for foundations shall be taken up by the contractor progressively stretch wise / section wise after obtaining approval from Employer the proposed stretch wise / section wise tower schedule, profile etc. as per detailed survey along the approved route alignment.

7.3.1.1.2 Except as specifically otherwise provided, all excavation for footings shall be made to the lines and grades of the foundations. The excavation wall shall be vertical and the pit dimensions shall be based on an assumed clearance of 150mm on all sides of the foundation pad. For footings with undercut, care shall be taken to carry out excavation as per drawing without any side clearance. All excavation shall be protected so as to maintain a clean sub grade and provide worker safety until the footing is placed, using timbering, shoring, shuttering, dewatering etc. as approved by the Employer. Contractor shall especially avoid disturbing the bearing surface of the pad. Any sand, mud, silt or other undesirable materials which may accumulate in the excavated pit or borehole shall be removed by Contractor before placing concrete.

7.3.1.1.3 The soil to be excavated for tower foundations shall be classified as follows depending upon the physical state of the soil at the time of excavation irrespective of the type of foundation installed.

a) Dry Soil

Soil removable either manually, by means of a spade and shovel or mechanically by proclaims, excavators etc.

Excavation done in dry soil for wet, partially submerged, fully submerged and wet black cotton type of foundations shall also be covered under this

b) Wet Soil

Where the subsoil water table is encountered within the range of foundation depth or land where pumping or bailing out of water is required due to presence of surface water shall be treated as wet soil. The excavation done in wet soil in case of wet, partially submerged, fully submerged and wet black cotton type of foundation shall also be covered under this .

c) Dry Fissured Rock

Limestone, laterite, hard conglomerate or other soft or fissured rock in dry condition which can be quarried or split with crowbars, wedges, pickaxes etc. However, if required, light blasting may be resorted to for loosening the material but this will not in any way entitle the material to be classified as hard rock.

d) Wet Fissured Rock

Above fissured rock, when encountered with subsoil water within the range of foundation depth or land where pumping or bailing out of water is required, shall be treated as wet fissured rock.

e) Hard Rock

Any rock excavation, other than specified under fissured rock above, for which blasting, drilling, chiseling are required. The unit rate quoted for hard rock excavation shall be inclusive of all costs for such drilling (including drilling required for anchoring), chiseling and blasting, etc.

7.3.1.1.4 No extra payment shall be admitted for the removal of fallen earth into a pit or borehole once excavated.

7.3.1.1.5 Where rock is encountered, the holes for tower footings shall preferably be drilled. Blasting where resorted to as an economy measure, shall be done with utmost care to minimise fracturing rock and using extra concrete for filling the blasted area. All necessary precautions for handling and use of blasting materials shall be taken. In cases where unnecessarily large quantities are excavated/blasted, resulting in placement of large volumes of concrete, payment of concrete shall be limited to design volumes of excavation, concreting, reinforcement etc. In case where drilling is done, the stubs may be shortened suitably with the approval of the Employer.

7.3.1.1.6 The Contractor shall arrange & supply requisite blasting material, and be responsible for its storage and use, without any extra cost to the Employer.

7.3.1.1.7 Local rules and regulations shall be followed regarding safety of excavation work.

7.3.2 Construction of Bored Cast In-Situ Pile foundation

7.3.2.1 General Requirement

7.3.2.1.1 ***The specification covers the technical requirements for piling work, general description of work, quality and workmanship. In every case, work shall be carried out to the satisfaction of the Employer in accordance with the Technical Specifications and conform to location, lines, grades and cross sections shown on the construction drawing or as directed by the Employer. The specifications are not, however, intended to cover all the minute details and the work shall be executed according to the specified Britsh Codes. In absence of the BS Codes, work shall be executed according to the best prevailing local Public Works Department practice or to the recommendations of the relevant International Standards or to the instructions of the Employer. This specification shall have precedence in case anything contrary to this is stated anywhere in this Bid Document. In case of conflict between the Specification and Codes, the former shall prevail.***

7.3.2.1.2 ***The work shall include mobilization of all necessary equipments, providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carry out the complete piling work. The minimum capacities of some key equipment are listed below. However, bidder has to furnish information regarding the equipments they intend to deploy for the project as per Performa stipulated in the relevant schedules of the BPS.***

Sl. No.	Description	Capacity
1.	Tripod height	6m. to 10m. (clear drop)
2.	Rig (winch) capacity	3 T to 5T
3.	Weight of chisel	2T to 3T
4.	Mud pump capacity	15 HP to 25 HP
5.	Dia. of outlet pipe for bentonite	2.5 inch

Note: Contractor may have to provide higher capacity equipments than mentioned above, as per the actual requirement for the execution of the job, without any additional financial implication to the Employer.

7.3.2.2 Site Preparation

This section of the specification covers site preparation of the areas as indicated in the drawings.

7.3.2.3 Reference Points and Bench Marks

7.3.2.3.1 **Permanent reference pillars have been established and under no circumstances shall the Contractor remove or disturb any permanent mark without the approval of the Employer. The Contractor shall carefully maintain and protect all bench marks and reference points and shall layout all his work by accurate reference thereto. The Contractor shall remove all vegetation, excluding trees, from the site areas as directed by the Employer.**

7.3.2.3.2 **The area shall be stripped to remove roots of grass, rubbish and slush, shrubs or other organic materials. Spoiled materials shall be burnt or removed to approved disposal areas on or near the job site as directed by the Employer.**

7.4 MATERIALS

7.4.1 Concrete

All works shall further be carried out in full compliance with all local rules and regulations and the specification. All materials used in the production of concrete, including all admixtures shall be in accordance with the requirements of BS 8500 and BS EN 206.

Cement shall be either:

(a) Ordinary Portland Cement (CEM I) in accordance with BS 12 & BS/BDS EN 197-1 strength grade 42.5N;
(b) Portland Composite Cement (CEM II) in accordance with BS/BDS EN 197-1 strength grade 42.5N;
(c) Sulphate resisting Portland cement in accordance with BS 4027 strength grade 42.5N LA;

The maximum particle size of the aggregates shall be so chosen as to be compatible with mixing, handling, placing, and workability of the concrete.

Throughout the construction period the quality of concrete mixed at and/or delivered to Site has to be controlled. Tests shall be carried out in the presence of the Engineer or under the supervision of an approved office for testing of such kind of works. The Contractor shall submit to the Engineer, test schedules on the following test at least one month prior to commencement.

(a) Aggregates
(b) Cement
(c) Water

(d) Admixtures and Additives

In case of placing ready mixed concrete, concrete tests can be replaced by the manufacturer's test results.

Concreting for pile foundation shall be done through tremie-pipes or equivalent devices to prevent segregation. For concreting in hot weather, ACI Standard 305R "Hot Weather Concreting" shall be followed and various means may be employed to lower the temperature of concrete such as:

- Cooling coarse aggregate with water by sprinkling and shading
- Using chilled water
- Avoiding the use of the hot cement
- Adequately watering of sub-grade, form-work and reinforcement
- Intensive moist-curing with potable water of the concrete placed

No admixtures shall be used without approval of the Engineer

Where appropriate the Contractor shall take cognisance of CIRIA Special Publication No.31. Recommendations contained in this report shall be adhered to except that in the event of any discrepancies this Specification will take precedence unless authorised by the Engineer.

7.4.2 Potential Alkali Reactivity

Aggregate shall not contain any materials that are reactive with alkalis in the aggregate itself, the cement, the mixing water or in the water in contact with the finished concrete or mortar in amounts sufficient to cause excessive localised or general expansion of the concrete or mortar.

The Contractor may initially assess an aggregate source by testing in accordance with ASTM C289. If potential reactivity is indicated, then mortar bar tests in accordance with ASTM C227 shall be carried out and the results shall comply with the limits given in ASTM C33, before use of the aggregate is approved. Details of the tests shall be submitted to the Engineer. This is a **Hold Point.**

7.4.3 Reinforcement

Unless specified to the contrary high yield steel reinforcement shall be either hot rolled deformed bars or cold worked deformed bars to BS 4449 and shall have type 2 bond classifications.

Mild steel reinforcing shall be plain hot rolled bars to BS 4449. Steel fabric or wrapping fabric shall be to BS 4483. Where mild steel hot rolled deformed bars are used they shall be generally in accordance with BS 4449. Reinforcement shall not be manufactured from scrap steel, unless otherwise approved by the Engineer.

Where specified fusion bonded epoxy coated reinforcement shall be in accordance with the requirements of BS ISO 14654 and 14656. Coated reinforcement shall be delivered to site in its cut and bent form.

Cropped ends and minor discontinuities of the fusion bonded coating shall be factory coated using a suitable repair compound formulated in accordance with the manufacturer's specification.

Where specified fibre enhanced concrete shall contain fibres manufactured from 100 percent virgin polypropylene fibre and designed to achieve maximum distribution and freedom from clustering in the mix.

7.4.4 Reinforcing Bar Coupler

The use of proprietary reinforcing bar couplers to extend reinforcement will be permitted. Details of the coupler system shall be submitted to the Engineer prior to their use. This is a **Hold Point.**

7.4.5 Spacers

Dense sand/cement mortar spacing blocks shall be of a low permeability having similar strength, durability and appearance to the surrounding concrete.

Details of patent spacers shall be submitted to the Engineer. This is a **Notification Point.**

7.4.6 Tying Wire

Tying wire shall be 1.6 mm diameter black annealed mild steel wire for uncoated mild or high yield steel reinforcement. Coated bars shall be fixed with plastic coated annealed mild steel tying wire.

7.4.7 Anchor Tendons

All the materials used in the installation of anchor tendons including those used for the grout shall be in accordance with the requirements of BS 8081 BS EN 1537.

7.4.8 Gabion Baskets

Gabion baskets and mattresses shall be manufactured from cold drawn steel wire. Minimum wire diameter for baskets galvanised to BS EN ISO 1461 shall be 3.0mm whilst for plastic coated wire galvanised to BS EN 10244-2 shall be 2.7mm. The minimum radial plastic coating thickness shall be 0.25mm.

All steel wires shall be electrically welded at every intersection.

7.4.9 Holding Down Bolts

NOT USED.

7.4.10 Piles

If pre-cast concrete or steel piles are used all materials shall be in accordance with the requirements of the IEC 'Specification for Piling'.

7.4.11 Stubs

Stub steelwork and bolts shall not be inferior to the requirements of Clause 8.3.1.

7.4.12 Earthing

All mild steel used in the manufacture of earthing rods shall comply with the requirements of BS EN 10083 etc.: (minimum strength 600N/m) Earthing rods shall have a minimum diameter of 14 mm.

Phosphor-bronze used in the manufacture of earthing rod couplings shall comply with the requirements of BS 12163 etc.

All compression fittings shall be manufactured from electrolytic tough pitch high conductivity copper, complying with the requirements of BS 13600 and BS EN 1057 and 12449, designation C101.

Earthing conductors shall be in accordance with the following requirements:

(a) Copper strip to BS EN 1652, 1653 and 1654, Grade C101 or C102, minimum cross sectional; dimensions 20 mm x 3 mm.
(b) Hard drawn copper strand to BS 7884, minimum overall diameter 10.65 (7 x 3.55 mm);
(c) Galvanised steel wire to BS 183, minimum overall diameter 9.75 mm (7 x 3.25 mm).

7.5 WORKMANSHIP

7.5.1 General

All workmanship shall be in accordance with the requirements of this Specification, the appropriate British Standard and local regulations including the appropriate health and safety requirements. The Contractor shall comply with all local regulations in respect of safety measures during construction at site. All local regulations shall also be adhered to. Proper strutting, sheeting and bracing, including rearrangement of the installations when necessary, protection of slopes, methods of excavation to reduce risk of slides, etc., shall be the Contractor's responsibility to meet the for design and construction requirements. And workmanship, shall be in accordance with the requirements of ACI 308.1, 301M, 301, 117-117R also.

7.5.2 Site Working Area

The Contractor will be restricted to a specified maximum working area at each tower site. He shall, where required, mark this area to clarify boundary lines to other parties. The Engineer shall be kept informed of any activities by others within the working area.

The Contractor shall remove all vegetation and other debris from the tower site, which will interfere with his operation. Vegetation and debris removed from the tower site shall be disposed off outside the right of way as directed by the Engineer and/or in accordance with local regulations.

The Contractor shall dispose of material and regulate the movement of equipment, and slopes necessary to develop required loading characteristics shall be maintained, especially in side-hill locations.

7.5.3 Supports of Excavation

Excavations shall be adequately supported or formed to ensure stability of the sides and prevent any damage to the surrounding ground or structures. The design of suitable sheet piling and/or timbering for the tower of foundation excavation shall be in accordance with the recommendations of BS 8004 Section 5.

When the Contractor is requested, shall submit details of his temporary support to the Engineer.

Excavation material suitable for re-uses, as backfill shall be stored within the site working area. Excavation top-soil shall be stored separately.

Excavated material unsuitable for re-use shall be removed from site to a recognised dumping area provided by the Contractor, and approved by the relevant authorities.

For excavation in cohesive material the final 150 mm above formation level shall only be removed immediately prior to placing the blinding concrete. This activity shall be programmed to be carried out on the same day.

Excavation shall not be carried out below or adjacent to existing building foundations until under-pinning and shoring has been completed by the Contractor. Existing structures, foundations, and services shall be adequately protected or re-routed by the Contractor.

The Contractor shall not permit water to accumulate in any excavation unless otherwise agreed. Any water whether arising from the excavation or draining into shall be drained or pumped to an approved location well clear of the excavation area in a manner that does not cause erosion, silting or contamination of existing drains and watercourses. Before the method of ground water lowering is selected, adequate knowledge of the ground and water conditions has to be obtained from the results of a soil investigation and/or information, which may be available from the Engineer.

The Contractor shall take adequate steps to prevent adjacent ground from being, adversely affected by loss of fines in any de-watering process.

7.5.4 Use of Explosives

The Contractor shall familiarise himself and comply with the laws and local customs concerning the use, handling and storage of explosives.

(a) Permission

Explosives shall not be used on the Site without the prior approval of the appropriate Military and Civil Security Authorities and without prior written approval of the Engineer. This is a **Hold Point.**

(b) Control

The handling of all explosives on site shall be carried out in accordance with local requirements.

(c) Approval

The Employer shall be given a minimum of 24 hours notice of a proposal to use blasting and shall be given any details they may require concerning the charges and their positions. This is a **Notification Point.**

The Employer may regulate, restrict or prohibit blasting, if in their opinion it is necessary to do so for the safety of persons, property, and limit noise or to safe guard the works.

(d) Blasting

For explosives to be allowed in any area of the site, the following and any local requirements shall be strictly observed.

i) The Contractor will be required to strip overburden and vegetation to expose rock which requires to be blasted;

ii) Where there is any danger of flying rock engineering persons or property, blasting screens made of approved materials shall be laid over the rock to be blasted, to help prevent dangerous projection of fragments;

iii) The use of electric detonators will not be permitted within 60 meters of any overhead power lines;

iv) Delay blasting techniques will be mandatory for all primary blasting with charge limits per delay period being imposed in order that ground vibration from the blasting can be controlled to a peak particle velocity of 25 mm/sec. in the vicinity of any structures or installations;

v) All charges prior to firing will be covered with thick gunny sacking and 1.8m squares of steel mesh weighed down with filled sandbags in order to prevent the projection of rock fragments;

vi) The Contractor will be required to take adequate and effective precautions to prevent debris rolling onto public or private roads and property.

The erection of magazines for storing explosives on site will not be permitted.

7.5.5 Reinforcement

(a) Storage

All reinforcement shall be adequately stored to prevent contamination or damage.

(b) Cutting and Bending

All reinforcement shall be bent cold unless otherwise permitted by the Engineer. Reinforcement shall not be straightened or re-bent in a manner which may cause injury to the material. All reinforcement shall be cut and bent in accordance with the requirements of BS 8666 and BS EN ISO 4066. The reinforcement shall be clearly identified with securely fixed, durable tags.

(c) Fixing

All reinforcement shall be rigidly fixed in position to the concrete cover specified by an approved means. The Contractor shall be responsible for ensuring that the reinforcement is properly towered and maintained in position by the adequate use of chairs, spacers and tying wire.

The reinforcement shall be free of all loose rust, scale or contamination of any kind. The reinforcement shall be inspected/checked after being fixed and no concrete shall be placed around the reinforcement until such checking/inspection has taken place and concrete permission has been signed by the Engineer.

(d) Site Bending

Bending and subsequent straightening of reinforcing bars projecting from the existing concrete shall be undertaking as follows:

i) Unless noted otherwise on the drawings, the minimum distance from the existing concrete to the beginning of a bend and the minimum inside diameter of the bend shall be:

7.1.1.1.1.1.1.1 Bar Diameter Min Distance from surface to beginning of bend *Min Inside bend radius (mm)*

10-24	3 Bar Diameters	3 Bar Diameters
25-32	4 Bar Diameters	3 Bar Diameters
<32	5 Bar Diameters	5 Bar Diameters

ii) Bars of 10 to 16 mm diameter may be bent once without heating, heating is required for subsequent straightening or bending.

Bars of 20 to 32 mm diameter may be bent once and subsequently straightened, heating is required in all cases.

Bars having a diameter greater than 32 mm may be bent only with the approval of the Engineer, heating are required in all cases.

iii) Heat shall be applied as uniformly as possible over a length of bar equal to 10 bar diameters. The centre of the heated length shall be at the centre of the completed bend. The temperature shall be maintained consistent during bending and straightening operations and shall not exceed 350°C. Temperature measuring crayons or a contact pyrometer shall be used to determine the temperature. Care shall be taken to prevent quenching of the heated bars either by application of water, or by a high volume of air.

iv) Straighten bars shall be visually inspected before and after straightening to determine whether they are cracked or otherwise damaged. This is a **Notification Point.**

(e) Epoxy Coated Bars

i) The Contractor shall take all necessary precautions to minimise damage to the coating during off-loading, handling and fixing. All equipment used for handling of coated bars shall have padded contact areas. Coated bars or bundles shall not be dropped or dragged.
ii) Coated bars shall be stored separately to uncoated bars.
iii) Coated bars shall not be cut or bent on site without the prior approval of the Engineer. This is a **Hold Point.**
Cut ends and any damage to the coating shall be repaired in accordance with Clause 7.5.
iv) Coated bars shall be towered on epoxy coated wire chairs or on chairs of dielectric material.

7.5.6 Concrete Trial Mixes

Trial concrete mixes using representative materials shall be carried out under full scale conditions using the Contractor's proposed method subject to the Engineer's approval. In case of use of ready mixed concrete, trial mixes shall only be waived, if an earlier proven mix design is used.

Testing shall be carried out in accordance with BS EN 12350. Trial mix test specimens shall be prepared and tested at approved laboratory. Aggregate used in trial mix shall be collected from the source proposed by the Contractor and approved by the Engineer. The target mean strength of the trial mixes shall be specified concrete cube strength plus adequate safety margin as stated in BS / ACI standard.

To ensure the durability of the concrete, the requirements specified in Appendix 7.A6 shall be adhered to with regard to characteristic strength, minimum cement content slump requirement and maximum free water/cement ratio.

The tests shall be carried out on three different days during which the workability will be recorded and nine cubes made. Among the nine cubes, three will be crushed at seven days; three will be crushed at fourteen days and the remaining three at twenty eight days. This is a **Notification Point.**

7.5.7 Batching

The aggregate and cement shall be proportioned by means of efficient weigh batching machines. The machine shall be carefully maintained and cleaned and they shall be provided with simple and convenient means of checking the weighing mechanism and they shall be checked when required by the Engineer.

Batch materials, shall be measured out within the following tolerances and shall be discharged into the mixer without loss.

Cement - ± 2 percent of the mass of the cement in the batch.

Aggregate - ± 2 percent of the mass of each aggregate in the batch.

Admixtures - ± 5 percent of the amount to be added to the batch.

Mixing Concrete by Machine

The concrete is to be mixed in batches in machines which comply with the requirement of BS 1305. The machines are to ensure that all the concreting materials including the water are thoroughly mixed together between the time of their deposition in the mixer and before any portion of the mixture is discharged. The machines must be capable of discharging their content while running.

7.5.8 Workability

The Contractor shall carry out slump or other workability tests as required during concreting of the works in order to relate the degree of workability of the mix with the numerical value obtained during the trial mixes.

7.5.9 Blinding Concrete

Blinding concrete shall be provided under specified foundations to a minimum thickness of 75 mm.

7.5.10 Formwork

All formwork shall be accurately constructed to prevent loss of grout and to produce the correct foundation shape. Formwork shall be sufficiently strong to withstand the pressures arising from the concrete during placing and compaction and shall be capable of removal without undue disturbance to the concrete.

All form-work and moulds shall be of such tight construction that slurry cannot flow out at the joints during pouring and compaction. If required, joints shall be sealed with foam rubber strips.

Formwork shall be retained in position after concreting for a minimum period of 48 hours.

7.5.11 Placing and Compacting

Concrete shall normally be discharged from the delivery vehicle within two hours after the time of loading at the ready mix plant in accordance with the requirements of BS 8500 and BS EN 206. With the Engineer's approval these periods may be exceeded with the use of a suitable retarded and/or plasticizer, provided that there is no change in the quality of the concrete. Concrete must at all times -have the desired workability and characteristics at the point of placing. Any concrete which no longer meets this requirement shall be removed from site.

Placing by pump, conveyor or pneumatic method shall be subject to approval by the Engineer. There shall not be any loss of quality in the concrete, nor harmful effects to the works by such methods. Concrete pumps shall be operated by mechanically applied pressure and shall produce a continuous stream of concrete without air pockets.

Where pumps are used the velocity of discharge shall be regulated, by suitable baffles or hoppers where necessary to prevent segregation or damage and distortion of the reinforcement, embedded items and formwork, caused by impact.

When pumps are used on large or complicated pours a standby pump shall be provided.

Precautions shall be taken to avoid depositing water or grout in the Works during starting up operations, or in flushing, or clearing the pipeline. The pipeline shall pass its own length of concrete in not more than 20 minutes.

Chutes used to deliver concrete shall not be sloped so as to cause segregation of the mix.

Concrete shall be fully, compacted by vibration or other approved means and shall completely fill the shutter. Immersion vibrators shall be inserted in such a manner and at intervals as will ensure the satisfactory uniform compaction of the concrete. The vibrator shall penetrate the full depth of the layer and where the underlying layer of concrete has not initially set, they shall enter and re-vibrate the layer to ensure that succeeding, layers are well bonded together. Withdrawal of vibrators shall be such as to prevent the formation of voids. Piles of concrete within the formwork shall not be moved by immersion of the vibrator, nor shall segregation be caused by over vibration. Undue laitance or leakage through the formwork shall be avoided. It shall be fully, worked around reinforcement and other embedded items which shall not be disturbed. The Contractor shall provide standby vibrators.

The Contractor shall maintain records of daily returns of the quantity, concrete mix and location within the Works of all concrete placed. These shall be forwarded to the Engineer when requested.

7.5.12 Joints

Construction joints shall be made across planes of minimum shear and away from planes of maximum bending moments. Vertical construction joints shall be made against properly constructed stop boards firmly fixed and holed where necessary to pass reinforcement. To ensure bond between old and new concrete at construction joints, surfaces of the cast (old) concrete shall be cleaned of all defective concrete, latency, oil, grease, dirt, loose concrete, etc. and shall properly be roughened by chipping, hammering or other techniques to expose the aggregates and provide sufficient key for the two layers.

The pad and chimney (for pad and chimney type foundations) shall normally be cast in one operation without construction joints. Where the formation of a joint is unavoidable the surface against which the fresh concrete is to be placed shall be prepared in accordance with Clause 6.12 of BS 81 10: Part 1. This is a **Notification Point.**

Construction joints in anchor or pile caps, monoblock and raft foundations shall be treated in similar manner to that described above. When the embedded reinforcement is insufficient to transmit the required design load, additional reinforcement in the form of 'starter' bars shall be provided. No construction joints are permitted in cast-in-situ concrete piles, drilled shaft or side bearing foundations.

7.5.13 Curing and Protection

Curing and protection shall start immediately after the compaction of the concrete and shall ensure adequate protection from:

(a) Premature drying out, particularly by solar radiation and wind;
(b) Leaching out by rain and flowing water;
(c) Rapid cooling during the first few days after placing;
(d) High internal thermal gradients;
(e) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement or other embedded items.

Where curing compounds are used to protect exposed surfaces from solar radiation and improve moisture retention, they shall be subject to the approval of the Employer. This is a **Hold Point.**

The temperature of the fresh concrete at the time of delivery on site shall be in accordance with requirements of BS 8500 and BS EN 206.

7.5.14 Grouting of Anchor Tendons

The installation and subsequent grouting of anchor tendons shall be in accordance with the requirements of BS 8081 and BS EN 1537.

7.5.15 Drilled Shaft piled Foundations

Drilled shaft shall be installed and concreted strictly in accordance with the recommendations of BS 8004 Sub-clause 7.4.5 and as summarised below:

(a) To ensure drilled shafts remain uncontaminated with spoil, shafts shall be extended by 300 mm or a depth equivalent to the total pitch of the auger blades (excluding continuous flight augers) below the calculated depth of the auger;

(b) When shafts are installed using bentonite slurry techniques the stability of the sides of the shaft shall be maintained throughout the installation by an adequate head of bentonite slurry in conjunction with the temporary casing;

(c) Reinforcing cages shall be provided with roller spacers of an approved type to ensure that the minimum specified concrete cover is achieved, especially as regards the cover at the bottom of the shaft;

(d) The tremie pipe shall have a minimum diameter of 150 mm and shall be filled with an effective plug prior to charging with concrete;

(e) Effective means shall be provided for raising or lowering the tremie quickly by towering the hopper from a crane. The hopper shall have a minimum capacity equivalent to that of the tremie;

(f) The tremie shall always be kept full of concrete and shall adequately penetrate into the concrete to prevent accidental withdrawal if the pipe is surged to discharge the concrete.

Piled foundations shall be installed in accordance with the requirements of the IEC 'Specification for Piling'.

7.5.16 Stub Setting

Stubs shall be held firmly in position by a stub setting template or other device while the concrete is placed. This tower shall be maintained until backfilling of the foundation is complete, or for drilled shaft, anchor and pile caps, monoblocks, rafts etc until a minimum period of 48 hours has elapsed after concreting.

Concrete blocks may be used to tower the lower end of the stub, and they shall have similar strength and durability to the surrounding concrete.

Where holding bolt assemblies are used, setting templates shall be used and retained in position for a minimum of 48 hours.
Stub setting templates shall be used to maintain the position of steel grillage foundation is during backfilling.

7.5.17 Backfilling of Foundations

Backfilling shall be compacted in 300 mm layers to achieve a bulk density of 1.6 Mg/m3, or the value assumed in the design analysis (if this is less than 1.6 Mg/m3).

Commencement of backfilling, shall be a **Notification Point.**

During backfilling, the side sheeting to the excavation shall, where possible, be progressively withdrawn such that the toe of the sheeting, is never more than 600 mm below the surface of the compacted material.

Extreme care shall be taken by the Contractor during compaction to ensure that the foundation is not damaged nor caused to move out of position. During the placing of backfill the hole shall be kept free

from water. All temporary timbering and all decomposable material shall be removed from the excavations prior to backfilling.

Refilling around the pile head pits shall be carried out only after all works within the excavations have been inspected and approved by the Engineer.

The Contractor shall select the compaction plant most suitable for achieving the required bulk density. Acceptable methods of compaction shall include, but not be restricted to, the use of vibrating plate compactor or diesel hand operated vibrating Wacker plate. The actual method of compaction selected will depend on the type of material to be compacted and the difficulty in accessing areas within the excavation.

Backfilling of the directly embedded pole annulus shall be undertaken using crushed rock aggregate in accordance with BS EN 12620, with a nominal maximum size of 40 mm.

7.5.18 Site Clearance

As soon as possible at each tower site, backfilling should be completed, surplus soil removed and the site cleared at the Contractor's cost. Final site clearance normally carried out at the same time as fitting of anti-climbing guards and danger and notice plates, shall be undertaken without delay. The Contractor shall be responsible for compacting and re-levelling ground to the original surface level and gradient. Where agreed by the Engineer a percentage of the spoil may be disposed of by local spreading and the balance, if any shall be removed from site.

7.5.19 Reinstatement of Working Areas

Reinstatement of all working, access and storage areas shall be the responsibility of the Contractor.

A programme for reinstatement works shall be submitted to and approved by the Engineer prior to the issue of the taking over certificate.

Reinstatement where specified shall include all necessary topsoil preparation, hydro-seeding and the planting of shrubs and trees to a standard at least equal to the condition of the site prior to construction. The sequence of work shall be such as to ensure establishment of all species and the age and state of growth of plants shall be such as to ensure successful replanting at site.

All such work shall be completed to the satisfaction of the Engineer and the relevant regulatory authorities.

7.5.20 Site Stabilisation

Where foundations are installed on sloping or unstable ground the Contractor shall be responsible for ensuring the stability of the area and the safety of the public, all to the satisfaction of the Engineer and local regulatory authorities.

Stabilisation shall be achieved by approved methods such as retaining walls, buttresses, sprayed concrete, rock bolts, dowels or gabion baskets/mattresses.

Site assembly of gabion baskets and mattresses shall be carried out in accordance with the manufacturer's instructions. Gabions shall be placed in position prior to filling and secured to adjoining gabions with lacing wire. Filling material shall be between 100 and 150 mm; 90 percent of the fill to be retained on a

100 mm ring. The fill shall be tightly packed with no apparent voids, and shall be overfilled by 25-50 mm to allow fat settlement lids shall be laced immediately after filling.

Where necessary to prevent erosion and as stipulated by the Engineer, or the appropriate authority, surface drainage channels shall be provided; surge chambers stopped ends and sub lets shall be formed as required. Where surface vegetation has been removed from sloping ground such that erosion could occur the area shall be reinstated by planting of grasses using hydro-seeding methods or band sprigging.

7.5.21 Site Protection

Where specified tower legs or foundations are in areas open to vehicle access, the Contractor shall install barriers of a type approved by the Engineer to prevent vehicle coming into contact with the tower or foundation.

7.5.22 Protection of Tower and Tower Footing

Tower shall be spotted such that the quantity of revetment is optimum. For tower locations in undulated terrain such as hill / mountain slopes, options like use of unequal leg extensions for towers, unequal chimney extensions etc. shall be explored by the contractor for optimizing the need for revetment & benching.

The work shall include all necessary stone revetments, concreting and earth filling above ground level, the clearing from site of all surplus excavated soil, special measures for protection of foundation close to or in nalas, river bank/ bed, undulated terrain, protection of up hill/ down hill slopes required for protection of tower etc., including suitable revetment or galvanised wire netting and meshing packed with boulders. The top cover of stone revetment shall be sealed with M-15 concrete (1:2:4 mix). Contractor shall recommend protection at such locations wherever required. Details of protection of tower/tower footing are given in drawing enclosed with these specifications for reference purpose only.

Tower footings shall generally be backfilled using soil excavated at site unless unsuitable for backfilling. In the latter case, backfilling shall be done with borrowed earth of suitable quality irrespective of leads and lift. The unit rate for backfilling quoted in BPS shall include the required lead and consolidation and leveling of earth after backfilling.

The provisional quantities for protection work of foundations are furnished in BPS. The unit rates shall also be applicable for any quantity variations during execution. The same unit rates shall hold good for protection work carried out on down hills or up hills slopes applicable for the tower locations.

The unit rates for random rubble masonry revetment quoted in price schedule shall also include excavation & (1:6) random masonry and unit rate for top sealing with M-15 concrete. For payment purposes the volume of random rubble masonry revetment shall be measured from bottom to top sealing coat and paid at the unit rates indicated in the Letter Of Award.

No extra payment shall be made for allied works such as excavation for revetment, packed stone at head of weep holes etc. However, no deduction shall be made for the volume enclosed by weep holes.

For some of the locations in nalas, river bed or undulated terrain etc., boulders of minimum. 150mm size bounded and packed in galvanised wire net/mesh of 8 SWG wire and 152 square (maxm.) mesh are to be provided. These stones shall be provided in crates size of 2.0mx2.0m or as deemed suitable for a

particular location. Measurement shall be taken in cubic meters and 15% deduction will be made for void from cage/stack measurements.

7.5.23 Earthing

The maximum tower footing resistance with earth wires disconnected shall be 5 ohms. Earthing shall be provided with two diagonal legs of each tower as shown in enclosed drawing. If additional earthing is required, additional earthing conductor shall be attached to the tower at the earthing holes specified and shall be sufficiently buried to prevent accidental excavation. The amount of earthing conductor to be buried or earthing rods installed will be dependent upon achieving the required footing resistance.

The excavation for the earthing conductor shall be 400 mm wide and not less than 800 mm deep in cultivated land where required by the Employer. The earthing conductor shall be laid at a depth of approximately 700 mm, being placed centrally in the trench. The trench shall be backfilled with a suitable medium.

The connection between the additional earthing conductor and tower leg shall be by approved thermo-weld joints.

Where necessary in areas of high resistance 90 mm diameter holes shall be drilled along the tower diagonal, each having, an earthing rod surrounded by a Bentonite/ sodium carbonate mix. The depth of hole depending on the resistance of the soil. The earth rod shall comprise standard rods coupled together and connected back, to the tower leg.

For towers within 150 m of a substation and connected to the substation earthing system, no additional earthing, will normally be required.

7.6 PROTECTIVE TREATMENT

7.6.1 Galvanising

All stub steelwork, pole sections and holding down bolts shall be protected by hot-dipped galvanising to comply with the requirements of BS EN ISO 1461.

7.6.2 Epoxy Coal Tar Paint

All directly embedded pole sections, steel pile and caisson sections, guy anchor rods shall be protected by two coats of epoxy coal tar paint. For steel pile sections, this treatment shall only apply to the initial 2 in below final -round level.

7.6.3 Epoxy Coated Reinforcement

Coating, damaged during transit handling or fixing shall be repaired only with the approved repair compound supplied, to ensure compatibility with the Fusion Bonded Epoxy Coating. All repairs shall be carried out strictly in accordance with the manufacturer's instructions.

When the extent of the coating damage on any metre length of bar exceeds 1% of the surface area, the bar shall be rejected. This is a **Notification Point.**

7.6.4 Tower Steelwork and Stub-Concrete Interface

After curing has been completed all exposed concrete above ground level and 300 mm below ground level shall be coated with Coal Tar Epoxy coating applied by either conventional spraying or brushing to give a minimum dry film thickness of 300 µm. The surface of the concrete shall be allowed to cure for at least 28 days prior to surface preparation unless otherwise agreed with the Engineer. After adequate curing all surface laitance, dirt and other contaminants shall be removed. Prior to the application of the coating, cracks in the concrete greater than 2mm in width and surface irregularities, including blow holes, with a depth greater than 10mm, shall be filled with a proprietary fairing coat compatible with the coating system. The surface of the substrate shall be prepared in accordance with the coating manufacturers recommendations. Primers where necessary, shall be obtained from the same manufacturer as the top coat.

All tower steelwork below the maximum anticipated flood level shall be protected by Coal Tar Epoxy coatings. All steelwork to a minimum height of 3m above ground level shall be protected by factory application with the remainder applied on site, including the stub above concrete level.

For factory application the galvanised steel members should be blast cleaned to a minimum Sa2 standard BS 7079 using a fine grade mineral blasting medium. The coating shall be applied by either conventional spraying or brushing to give a minimum dry-film thickness of 300 µm. Prior to application, the Coatings Applicator shall submit procedures for coating, application and quality control measures for approval by the Engineer. This is a **Hold Point.**

The method of application of the coating system shall be in accordance with the approved procedures and manufacturer's instructions. The contractor shall ensure that the proposed coverage rates will enable the specified minimum dry film thickness of each coat to be attained. Wet film thickness gauges shall be used to check the thickness of the applied coating.

Each application of the coating shall be generally free from surface defects, particularly catering, pin-holing, ravelling, and sagging, battiness, and dry spray and cussing. The finished system shall have a uniform appearance.

For site application the same procedure shall be adopted except that use of a 'etch primer' instead of blast cleaning on site will be permitted. The 'etch primer' must be obtained from the same supplier as the coating and applied strictly in accordance with the manufacturers instructions including the cleaning and decreasing of the tower steelwork on site.

7.6.5 Earthing Material

Steel earth rods shall be clad with 99.9 percent electrolytic pure copper molecularly bonded to the steel, with a minimum thickness of 0.35 mm. The earthing conductor at the ground interface and at the connection to the tower shall be protected against corrosion.

7.6.6 Protection of Buried Steelwork

Where it is necessary for tower steelwork to be buried, it shall be buried not more than 1.0 m and shall be protected by an approved medium e.g. mastic impregnated tape or bitumastic paint. Details of the

proposed materials, application and Quality Control procedure shall be submitted to the Engineer. This is a **Hold Point.**

7.7 QUALITY CONTROL

7.7.1 General

Type, sample and routine tests shall be undertaken on all materials used in the construction of the foundations, and where appropriate on the complete foundations, or parts of the complete foundation in accordance with the requirements of this Specification.

7.7.2 Bentonite Slurries

Bentonite slurries used to tower the sides of the drilled shaft foundations shall be prepared and controlled in accordance with the recommendations of BS 8004 Clause 6.5.3.8 and as summarised below:

(a) Bentonite shall be supplied in accordance with the Oil Companies Materials Association Specification No. DFCP4;
(b) After mixing, with clean fresh water the fully hydrated bentonite slurry shall have a density of less than 1. 10 g/ml, a viscosity as measured by the Marsh cone between 30s to 90s and a 10 minute gel strength in the range of 1.4 to 10 N/m2;
(c) Immediately prior to concreting, the density of the slurry at a level of 200 mm above the bottom of the shaft shall be less than 1.5 g/ml;
(d) The pH value of the slurry shall be maintained within the range of 9.5 to 12.

7.7.3 Reinforcement

All reinforcement shall be supplied from approved suppliers, complete with the appropriate test certificates in respect of the test requirements of BS 4449 or BS 4483 as appropriate. Copies of these certificates shall be made available to the Engineer upon request. Where test certificates are not available the Contractor shall arrange for the tests to be undertaken in accordance with the specified standards.

7.7.4 Inspection Prior to Concreting

The Contractor shall give the requisite period of notice to the Engineer of his intention to commence any concreting and shall submit at the same time a record of his inspection of completed preparatory works. Which shall include all works related to the fixing of reinforcement? This is a **Notification Point.**

7.7.5 Trial Mixes

A trial mix will be approved when the requirements of BS 8500 and BS EN 206 are met. Copies of the trial mix test results shall be submitted to the Engineer.

7.7.6 Workability

The Contractor shall carry out slump or other workability tests as required during concreting of the works in order to relate the degree of workability of the mix with the numerical value obtained during the trial mix.

Slump tests shall be carried out in accordance with the procedure laid down in BS EN 12350-1. A slump test will be accepted as complying with the Specification when the results are within the following limits:

±25 mm or ± one third of the required value, whichever is the greater.

7.7.6.1 Works Cubes

Compliance with the specified characteristic strength shall be based on tests made on cubes at twenty eight days. Cubes shall be made, cured and tested in accordance with BS EN 12350-1. Samples of Concrete shall be taken at the point of discharge from the delivery vehicle.

Unless otherwise directed by the Engineer one set of cubes shall be prepared for each $6m^3$ of concrete placed or tower foundation subject to one set of cubes being formed on each day that concreting is carried out or tower pile foundation subject to one set of cubes being formed on casting of each pile.

One set of cubes consisting of four test cubes shall be made from the working concrete.

In preparation of test cubes/specimens vibrators shall not be used.

Concrete shall be tested for slump at every 1 hour interval.

Each set of cubes shall be accompanied by a certificate noting the details required by BS EN 12350-1.

Cubes shall be tested in accordance with BS EN 12350-1 to determine the density and characteristic strength as follows:

(a) One cube shall be tested at seven days to provide an early indication as to whether the twenty eight day strength is likely to be achieved;
(b) Two cubes shall be tested at twenty eight days, the average strength shall be deemed the test results;
(c) One cube shall be held in reserve for further testing, if required.

The test report shall provide information in accordance with BS EN 12350-1.

Concrete shall be assumed to have achieved its characteristic strength when, at twenty eight days, the conditions specified in BS 8500 and BS EN 206 are met.

Copies of the test reports shall be made available to the Engineer on a regular basis. This is a **Notification Point.**

The Employer will consider whether the concrete in the Works represented by cubes falling below the limits laid down can be accepted, and he may order that any or all of the following, actions shall be taken:

i) Penetration resistance or surface hardness tests;
ii) The drilling of test cylinders in the concrete and testing the samples to destruction by compression;
iii) The cutting out and replacement of such volumes at their discretion which they consider to be defective;

7.7.7 Setting Out Tolerance

Towers shall be centre-pegged with a displacement along the line of the route not greater than 2 in relative to the profile, and to a displacement in transverse alignment not greater than 50 mm relative to a theoretical line adjoining the adjacent angle pegs.

7.7.8 Foundation Setting Tolerances

The maximum permitted stub tolerances measured at the top of the stubs shall be as detailed in Table 7.1 and are to apply immediately prior to erecting the tower. Should these tolerances not be achieved the Contractor shall submit details of his proposed remedial measures to the Engineer for approval. This is a **Hold Point.**

Records of the foundation setting out measurements shall be made available to the Employer.

Table 7.1 - Foundation Setting Tolerances

Principal Dimension	Tolerance
Nominal face dimension	10 mm or ± 0. 1% of face dimension (whichever is greater)
Nominal diagonal dimension	± 15 mm or ± 0. 1% of diagonal dimension (whichever is greater)
Rake of stub from required face or hip slope	1:100
Stub level	
(a) Maximum difference in level between all dimension (whichever is greater)	10 mm or 0.05% of diagonal four stubs of a foundation
(b) Maximum difference between the mean levels of pairs of diagonally opposite stubs	±6mm
Twist of stub in plan	1˚ about longitudinal axis

7.7.9 Backfilling

Testing of the backfill to ensure that the design value of soil bulk density is achieved may be undertaken using an approved penetrometer. Results of the tests shall be made available on request to the Engineer. However, the Engineer reserves the right to request the Contractor to undertake in-situ density tests in accordance with-BS 1377 Part 9 as necessary.

Where imported back-fill is required the following details shall be supplied to the Engineer:

(a) the type of fill
(b) evidence that when compacted a bulk density consistent with the value assumed in the design can be achieved.

7.7.10 Foundation Tests - General

When requested by the Engineer full scale foundations tests both design and routine/proof shall be undertaken on all types of foundations.

Tests shall unless specified otherwise be undertaken in accordance with IEC 61773.

When design tests are required, the sites selected shall be representative of the geo-technical conditions throughout the length of the transmission line, in which the Contractor proposes to install that type of foundation.

The Contractor shall submit to the Engineer the following information:

(a) Details of the test sites, including all geotechnical parameters;
(b) Details of the proposed test equipment, test layout, measuring equipment, test procedure and the test program. This a **Hold Point.**
(c) On completion of the design tests the requisite number of test reports shall be submitted to the Engineer.

The ultimate resistance of the foundation shall unless otherwise specified be determined from the lesser of:

i) the resistance equivalent to a temporary displacement of 25 mm or,
ii) the resistance equivalent to a permanent displacement of 10 mm.

Reports on pile testing shall be submitted to the Engineer and shall contain, among others, the following information:

(a) Layout of test equipment and description
(b) Pile identification, diameter and length
(c) Sketch of soil conditions and ground water location
(d) Complete records of level, load cell and dial gauge readings against date and time throughout the test in a tabulation
(e) Graphs of load and settlement/heave versus time
(f) Graphs of settlement/heave versus load
(g) Remarks concerning any unusual occurrences during the loading of the pile.

(h) Test reports on integrity testing of piles shall include clear sample diagrams of acceptable signals for comparison purpose, as well as sample graphs indicating defects or doubts on the integrity of the pile.

The Engineer will decide on completion of tests and evaluations whether the test piles shall be left in place or shall be extracted. No extra payment will be made for the extraction of test piles.

7.7.11 Concrete Pad & Chimney Foundation - Tests

Not used.

7.7.12 Piled Foundation - Tests

Unless specified to the contrary, design uplift and compression tests on piled foundations (service piles selected by Employer) shall be undertaken. The Contractor shall give the Engineer testing procedure for approval and the requisite period of notice prior to undertaking the tests. This is a **Hold Point.**

The tested pile shall be deemed to comply with its specified ultimate load when, after the load is held for at least 30 minutes, the following criteria are satisfied:

i) The displacement at the head of the pile is less than 25 mm or
ii) The movement of the head of the pile shall be slowing down and less than 0.25 run/hour
iii) The displacement at the head of the pile after all load is removed (after 10 minutes) is less than 10 mm.

7.7.13 Integrity Testing

Integrity tests shall be performed on drilled shaft concrete piled foundations selected by Employer for checking the uniformity, continuity and length of such piles using the acoustic pulse echo method shall be undertaken by a specialist subcontractor appointed by the Contractor. Details of practical experience of the subcontractor along with details of the test equipment, procedure of testing, presentation of test data/results shall be submitted along with tender. The integrity test shall be done at least one time for one pile of each leg selected by the Engineer. The actual method of performing the tests and the interpreting the results shall be subject to the Engineer's approval. This is a **Hold Point.**

The Contractor shall give the Engineer the requisite period of notice prior to undertaking the tests. This is a **Notification Point.**

The results of the integrity testing shall be made available to the Engineer upon request.

7.7.14 Earthing Resistance Test

Earth electrical resistance tests shall be undertaken at each tower prior to the erection of the earth wire. The Contractor shall give the Engineer the requisite period of notice prior to undertaking the tests. This is a **Notification Point.**

On sites subject to seasonal variations in the rainfall, or the level of the water table and sites requiring special earthing arrangements additional earth resistance tests shall be carried out at intervals to establish the affects on the resistance of such seasonal variations.

The method of measurement and equipment to be used shall be subject to the approval of the Engineer. This is a **Hold Point.**

The results of the earth resistance tests both initial and final i.e. after additional earthing has been installed shall be forwarded to the Engineer.

7.7.15 Protective Coatings

Where protective coatings are applied to buried tower steelwork or to exposed concrete surfaces, appropriate routine tests to demonstrate the quality of application shall be undertaken.

The Contractor shall submit to the Engineer his routine test proposals.

This is a **Hold Point.**

The Contractor shall give the Engineer the requisite period of notice prior to undertaking the tests. This is a **Notification Point**. The results of the tests shall be made available to the Engineer upon request.

7.8 RATES AND MEASUREMENT

7.8.1 Open cast Foundation

7.8.1.1 The indicative shape of foundations is enclosed in this Specification. The bidder is required to quote the unit rates for different foundation activity namely, excavation for different types of soils, concreting, supply and placement of reinforcement steel and stub setting in the BPS.

7.8.1.2 The unit rates of excavation for each type of soil shall include excavation along with all associated activities like shoring, shuttering, dewatering till completion of foundation work stock piling, dressing, back filling of foundations after concreting with excavated/borrowed earth (irrespective of lead) and consolidation of earth, carriage of surplus earth to the suitable point of disposal as required by the Employer or any other activity required for to completion of foundation work in all respect.

7.8.1.3 The measurement for excavation shall be made on the basis of design excavation volume arrived at considering dimension of pit leaving 150mm gap around (except for under cut foundations) the base pad or actually excavated whichever is less and the unit rate of this item as indicated in Letter of Award. The payment for excavation shall be made as per actual type of soil encountered at the time of excavation, but the total payment for excavation portion shall not exceed the amount as payable for excavation considering the soil type same as that of foundation classification. The decision of the Employer shall be final and binding with respect to classification of soil and foundations.

7.8.1.4 Form boxes shall be used for casting of foundations. The unit rate of concreting shall include the cost of supply, fabrication and placement of form boxes, cement, water, coarse and fine aggregates mixing and placing of concrete, curing of concrete and any other activities related / required for completion of concreting works of foundation. The payment for this item shall be made as per the actual volumes of concreting completed but limited to design volume based on unit rates indicated in the letter of award.

7.8.1.5 The unit rate of 'Reinforcement Steel' shall include supply and placement of reinforcement steel, stirrups, wire for binding the reinforcement, chairs, bolsters and spacers etc. as required to complete the foundation work. The payment of reinforcement steel shall be made based on the working drawing. Wastage overlaps, spacer bars, chairs, stays, hanger and annealed steel wire shall not be measured for the payment and cost of these items shall e deemed to be included in the rates for reinforcement.

7.8.2 Pile Foundation

7.8.2.1 Excavation

7.8.2.1.1 The unit rate for excavation shall be quoted by the Bidder in the respective schedule of BPS. The unit rate quoted shall hold good for excavation (other than boring) for all depth and size in all types of soil including sheet piling, sheeting, shoring, bracing, draining, dewatering, cofferdams etc. as required for successful completion of job.

7.8.2.1.2 The unit of measurement shall be in cubic meter. The design excavation volume shall be calculated considering dimension of pile cap plus 150mm on all sides of the pile cap and depth as shown in the drawing below the lean concrete level. The payment shall be made based on unit rate quoted, for excavation actually carried out or as per the design excavation volume as calculated above, whichever

is less. No extra payment shall be admissible for excavations if required to be carried out in slope to maintain stability of pit.

7.8.2.1.3 The Contractor shall arrange to transport the excavated soil to a distance as directed by Employer and the rates quoted for excavation in Price schedule shall include all lead, lift, carriage etc.

7.8.2.2 **Cement Concrete**

7.8.2.2.1 ***Actual volume of work as executed or as per drawing issued, whichever is less, measured in cubic meter corrected up to second place of decimal shall be considered for payment as per unit rate quoted in BPS. Deductions for openings, conduits, pipes, ducts, pockets etc. shall only be made provided they are larger than 0.1 sq.m. in area (for each opening) .***

7.8.2.2.2 No deduction shall be made for embedded fixtures including reinforcement, sleeves, anchor bolts and similar items.

7.8.2.2.3 The volume for structural concrete and lean concrete shall be measured separately.

7.8.2.3 **Form Work**

7.8.2.3.1 Formworks of different types / shapes shall be measured with reference to actual surface area in contact with the concrete and paid on area basis. The unit of measurement will be in sq.m. corrected up-to second place of decimal.

7.8.2.3.2 No payments for formwork for construction joints shall be made.

7.8.2.3.3 Opening up to 0.1 sq.m. of boxing left for inserts etc. shall not be considered as if non-existent for the purpose of formwork measurement of surface in which the opening occur. If the cross-sectional area of any openings exceeds 0.1 sq.m., area of such openings shall be measured and deducted from the area payable for the form work.

7.8.2.3.4 No payment shall be made for making the formwork water proof or for supports, scaffolding, centering, approaches, etc.

7.8.2.3.5 No separate payment shall be made for using fillets for rounding of chamfering junctions, corners, etc.

7.8.2.4 **Back filling**

The actual volume of backfilling shall be measured in cubic meter rounded off up to 2nd place of decimal and the unit rate shall include all the necessary operations required to complete the work as per drawing & Specifications stated in this section.

7.8.2.5 **Reinforcement Steel**

7.8.2.5.1 The unit rate for reinforcement steel shall include supply and placement of reinforcement steel of specific grade, stirrups, annealed wire for binding the reinforcement, chairs, hangers, spacers, welding, tack welding etc. as required to complete the RCC work in pile, pile cap, pedestal/chimney, tie beam (if required) including cleaning, straightening, cutting, bending, binding etc. The unit rate shall

also include placement of reinforcement cage in pile shaft/bore and all other cost for tools, plants, materials, labour, and transportation to site by appropriate means as required. The measurement for payments shall be made in Metric Ton (MT) corrected up to third place of decimal based on the calculated weight of reinforcement steel as per construction drawing and with reference to the sectional weights of respective size of reinforcement bars as per Indian Standards or reinforcement bars actually provided, which ever is less. The unit rate quoted shall be inclusive of all wastage.

7.8.2.5.2 Standard hooks, cranks, bends, authorised laps, etc. shall be measured.

7.8.2.5.3 Separator pieces between two or more layers of steel shall not be measured.

7.8.2.5.4 No payment shall be made for supports, spacers, chairs, hangers, etc. of height/length of 300mm and less, required for keeping the steel in position. For supporting horizontal reinforcement at heights, drawings for supports, spacers, chairs, hangers, etc. larger than 300mm, shall be prepared by the Contractor and got it approved from Employer. Payment shall be made for these supports as approved by the Employer, or as actually provided, whichever is less, as per the unit rate quoted for reinforcement.

7.8.2.5.5 No extra payment shall be made for modification of already embedded reinforcement, if required due to faulty fabrication or placement.

7.8.2.5.6 Dowels as required for completion of the work shall be provided by the contractor which will not be separately calculated for payment.

7.8.2.6 **Piling work**

7.8.2.6.1 The items of works are briefly described in the BPS. The various items in the BPS shall be read in conjunction with the corresponding sections in the Technical Specifications, including amendments, and additions, if any. The unit rate quoted for items shall include all the activities covered in the description of the item as well as all necessary operations described in the specification and any other specific requirements.

7.8.2.6.2 The unit rates shall also include all minor activities which are obviously and fairly intended, though may not have been clearly brought out in the description of items or in these documents, but are essential for the satisfactory completion of the work.

7.8.2.6.3 Unit rates shall also include for all safety measures as required by Codal provisions, local regulations, acts, bye-laws, etc. and mobilization of all plant, equipment, scaffolding, materials, skilled and unskilled labour, de-mobilisation after completion of work, supervision, establishing level and coordinates at each location by carrying levels from one established bench mark and distances from one set of grid lines furnished by the Employer.

7.8.2.6.4 Unit rate on per meter length basis for a particular diameter of pile shall remain unchanged irrespective of the actual length/depth of individual piles executed at any location

7.8.2.6.5 Unit rate for pile boring through all kind of soil, including weathered rocks, laterite, shell, hard rock shall be inclusive of cost of boring by approved method, bailing out all the pile bore spoils from the

pile bore, keeping the bore hole free from bored material/debris etc. and disposing same along with the drilling mud up to a distance of 2 Kms., flushing the pile bore by fresh bentonite before concreting, collection of samples from bottom of pile bore, transporting to laboratory, testing and reporting of results including necessary materials, equipment and manpower.

7.8.2.6.6 Unit rate quoted for pile boring through soil including weathered rocks, laterite, shell, hard rock shall include shifting of plant and equipment from one pile location to another location, providing temporary casing as required and removal of the same after completing concreting. The quoted unit rate for boring/installation of pile shall also be inclusive of the empty boring and extra concreting required above the pile cut off level.

7.8.2.6.7 Unit rate for pile boring through soil including weathered rock / laterite shall also include chiseling, if any required, the chiseling through rock in the pile below socketing horizon up to the specified level shall be inclusive of bailing out the pile bore debris/spoils from the pile bore and disposing off the chiseled materials/debris along with the sludge/mud up to 2 kms., flushing the pile bore by fresh betonies before concreting, collection of samples from bottom of the pile bore, transporting to laboratory, testing and reporting of results.

7.8.2.6.8 Unit rate of pile boring shall include concreting in piles by tremie method only, cost of preparation of pile head and disposal of debris etc., resulting from breaking off of pile up to COL, up to a distance of 2 km.

7.8.2.6.9 Unit rates shall include for all quality assurance requirements, but not limited to providing for technical inspection, transportation of samples to laboratory, testing samples, maintaining and submitting all test records, etc.

7.8.2.6.10 The rate quoted for boring and installation shall be inclusive of performing point load test on the rock samples obtained from bore spoils during the chiseling operations, and shall be inclusive of transportation to laboratory, testing and reporting of the results.

7.8.2.6.11 Measurement for the item of boring through soil including weathered rock shall be done by linear measurement for the length bored from the pile cut off level or ground level whichever is lower through soil/weathered rock up to termination /founding level as per drawing or actual length achieved of the pile in meters, up to second place of decimal.

7.8.2.7 **Pile Integrity Test**

The actual quantity of pile integrity test done shall be calculated in nos. and the unit rate quoted shall be include all necessary equipments, manpower, labor, materials, operations etc. required to complete the work as per clause 7.7.13 of this section. The payment shall only be made after successful completion of the job and submission of complete report for each no. of test.

7.8.2.8 **Piled Foundation - Tests**

The actual quantity of pile load test done shall be calculated in nos. and the unit rate quoted shall be include all necessary equipments, manpower, labor, materials, operations etc. required to complete the work as per clause 7.7.14 of this section. The payment shall only be made after successful completion of the job and submission of complete report for each no. of test.

APPENDIX 7.A1

FOUNDATION TYPES & USES

Note:

Soil Category	Allowable Foundation Type
1	Concrete Pad & Chimney/ Drilled Shaft Piled*/Rigid Frame Foundation**
2	Concrete Pad & Chimney/ Drilled Shaft Piled*/Rigid Frame Foundation**
3	Concrete Pad & Chimney/ Raft/ Drilled Shaft Piled*/Rigid Frame Foundation**
4	Concrete Pad & Chimney/ Drilled Shaft Piled*/Rigid Frame Foundation**

Seismic zone coefficient, G=0.1 shall be considered.

* The bidder may propose any other proven type of piled foundation instead of Drilled Shaft Piled foundation except wooden pile. The bidder shall submit the design of the proposed type of piled foundation along with detailed design calculation, installation procedure with drawings, Quality Control procedure, Standards and Codes of Practices to be followed, advantages of selecting such type of piles, etc. with the bid. Reinforced concrete pile caps shall be used for all types of piles. Payments of all types of foundations shall be as per prices quoted in the Price Schedule.

** Foundations at high flood level area shall be rigid frame with multiple drilled or mechanically excavated cast-in-situ piled. The Contractor shall submit his proposed method of installation and Quality Control procedures to the Engineer prior to commencing his design. This is a **Hold Point**.

Due cognizance shall be taken of the setting level of the base of the tower relative to ground level, the maximum depth of flood water. Individual footings shall be interconnected by tie beams, which shall be adequate to resist lateral forces and hydrostatic pressure exerted by the flood water. A Cyclonic surge of 6m shall be considered for detailed design of tower and foundation for river crossing in the estuary.

As the location of river crossing towers are supposed to be submerged during most of year, temporary islands will be required to be built by the Contractor for foundation works of river crossing towers.

APPENDIX 7.A2

FOUNDATION STRENGTH FACTOR

Annex 7-A2 (1): Foundation Overload Factor: 400kV Quad Finch or equivalent Double Circuit Towers-Not used

The following overload factor shall be used to increase the ultimate tower reactions on the foundations for the design of the foundations:

Applied Loading Case	Overload Factor for Foundation for all Tower Type
All load case	1.35

Annex 7-A2 (2): Foundation Overload Factor: 400kV Twin Finch Double Circuit Towers - Not used

The following overload factor shall be used to increase the ultimate tower reactions on the foundations for the design of the foundations:

Applied Loading Case	Overload Factor for Foundation for Tower Type	
All load case	4DL	4D1, 4D25, 4D45,4DT60
	1.33	1.45

Annex 7-A2(3): Foundation Overload Factor: 230kV Twin Mallard Double Circuit Towers (High Wind Zone) - Not used

The following overload factor shall be used to increase the ultimate tower reactions on the foundations for the design of the foundations:

Applied Loading Case	Overload Factor for Foundation for all Tower Type	
All load case	2DL	2D1, 2D25, 2DT6, 2D9
	1.23	1.35

Annex 7- A2 (4): Foundation Overload Factor: 230kV Twin Mallard Double Circuit River Crossing Towers (High Wind Zone) - Not used

The following overload factor shall be used to increase the ultimate tower reactions on the foundations for the design of the foundations:

Applied Loading Case	**Overload Factor for Foundation for all Tower Type**	
All load case	2DR	2DAX
	1.23	1.35

Annex 7- A2 (5): Foundation Overload Factor: 230kV Twin Mallard Double Circuit Towers (Medium Wind Zone) - Not used

The following overload factor shall be used to increase the ultimate tower reactions on the foundations for the design of the foundations:

Applied Loading Case	**Overload Factor for Foundation for all Tower Type**	
All load case	2DL	2D3, 2D25, 2DT6
	1.23	1.35

Annex 7- A2 (6): Foundation Overload Factor: 230kV Twin Mallard Four Circuit Towers- Not used

The following strength factors shall be used to increase the ultimate tower reactions on the foundations for the design of the foundations:

Applied Loading Case	**Strength Factor**	
	Tower Type	
	2QL	2Q15, 2Q30, 2QT6
Normal Condition, High Intensity Local wind condition	1.33	1.60
Security Condition	1.60	1.90

Annex-7.A2 (7): Foundation Overload Factor: 132 kV Single Grosbeak Double Circuit Towers (Narrow Base) - Used

The following overload factor shall be used to increase the ultimate tower reactions on the foundations for the design of the foundations:

Applied Loading Case	Overload Factor for Foundation for all Tower Type
All load case	1.23

Annex 7- A2 (8): Foundation Overload Factor: 132kV Single Grosbeak Four Circuit Towers- Used

The following strength factors shall be used to increase the ultimate tower reactions on the foundations for the design of the foundations:

Applied Loading Case	Overload Factor for Foundation	
	Tower Type	
	1QL	1Q15, 1Q30, 1QT6
All load case	1.23	1.35

The following strength factors shall be used to increase the ultimate tower reactions to get allowable load on the foundations for the design of the foundations:

Applied Loading Case	Strength Factor	
	Tower Type	
	1DL,1D1, 1QL	1D25, 1DT6,1Q15,1Q30,1QT6,1DR,1DAX
All Load Cases	1.23	1.35

APPENDIX 7.A3

NOT USED

APPENDIX 7.A4

GEOTECHNICAL PARAMETERS
(Tender Purposes only)

Parameter		Soil Category				
		1		2	3	4
Soil classification		Dense sand or very stiff hard clay		Medium sand or stiff clay	Loose sand or soft to medium clay	Very loose sand or very soft to soft clay
SPT "N" blows 1. Average SPT from existing ground level to 75% of length of pile in case of pile foundation 2. Average SPT of top 5 meter soil from existing ground level case of pad & chimney foundation		>20		<10-20	5-10	<5
Water level		At (depth of foundation + width of foundation) from EGL		At ground level		
Soil density	kN/m^3	16		8	7.5	7
Backfill density	kN/m^3	16		8	7.5	7
Concrete Density	kN/m^3	24		14	14	14
Allowable bearing pressure under ultimate applied loading	kN/m^3	CLAY	250	150	75	25
		SAND	350	250	120	80
Lateral earth pressure (for shallow foundation)	kN/m^3	Rankin's theory of earth pressure is applicable				
Frustum angle (degrees to vertical)		15	15		10	0

For sandy soil Ultimate skin friction = $K\ p_d\ \tan\delta\ A_s$ Bored piles δ Driven piles: Steel δ Concrete δ	 ¾ Φ 20° ¾ Φ	Where, K = lateral earth pressure coefficient; p_d = average effective overburden pressure; φ = angle of internal friction; A_s = surface area of pile shaft;
For clay soil Ultimate skin friction = $\alpha_2\ C_U\ A_s$	α_2 = 0.3 to 0.7	where α_2 = reduction coefficient; C_U = Undrained shear strength;

APPENDIX 7.A4 (Continued)
Minimum Factor of safety for Foundations :

Parameter	Requirement
Minimum factor of safety for pad & chimney and piles or drilled shafts i.e. Ultimate resistance to allowable load (For all types of soil categories)	1.5
Minimum percentage of ultimate uplift load **(without foundation strength factor)** to be resisted by submerged dead weight of piles & pile cap (For soil category 4 of pile foundation only)	28%

APPENDIX 7.A5

DETERMINATION OF DEPTH OF FIXITY, LATERAL DEFLECTIONAND MAXIMUM MOMENT OF LATERALLY LOADED PILES

7-1. Determination of Lateral Deflection at The Pilehead and Depth of Fixity

7.1.1 The long flexible pile, fully or partially embedded, is treated as acantilever fixed at some depth below the ground level (see Fig. 2).

7-1.2 Determine the depth of fixity and hence the equivalent length ofthe cantilever using the plots given in Fig. 2.

Where $$T = \left(\frac{EI}{K_1}\right)^{\left(\frac{1}{5}\right)}$$

(k_1 is a constants given in Tables 1 below, E is the Young's modulus of the pile material in kg/cm2 and I is the moment of inertia of the pile cross-section in cm^4).

Note: Fig. 2 is valid for long flexible piles where the embedded length Le is ≥ 4R or 4T.

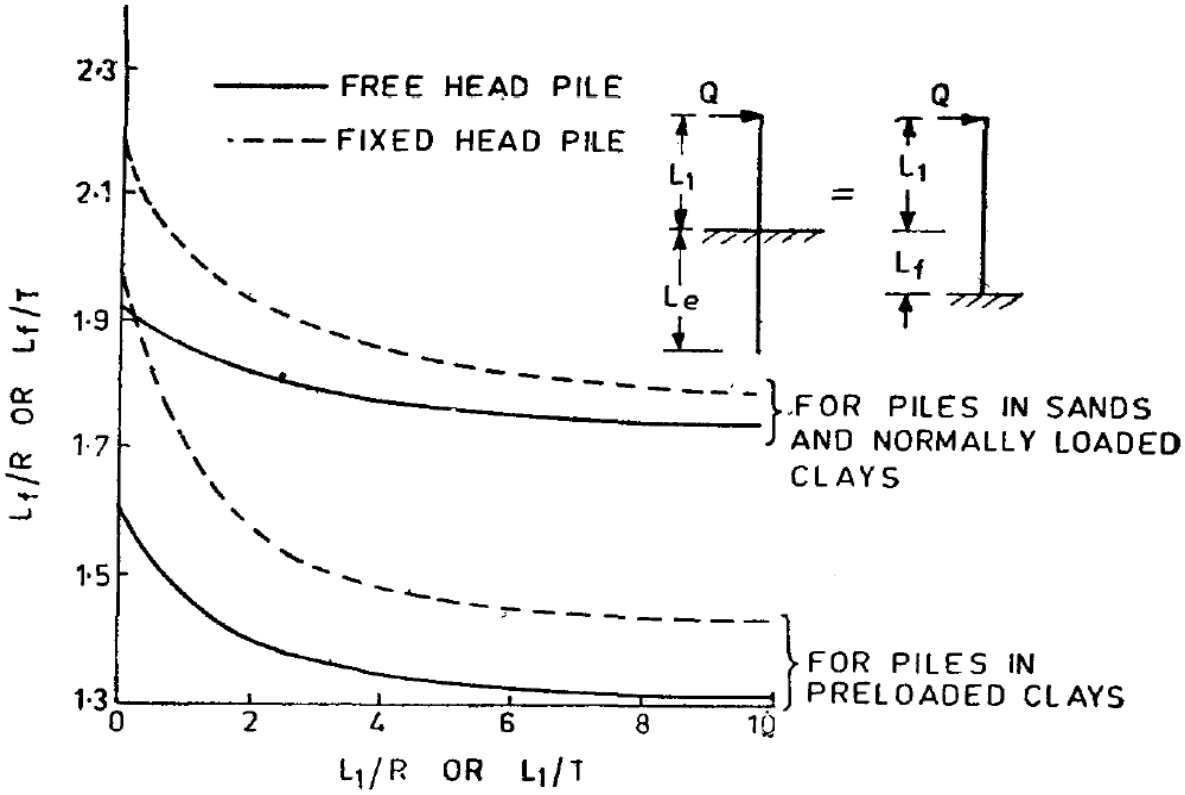


FIG. 2 DETERMINATION OF DEPTH FIXITY

K_1 is the constant of modulus of horizontal subgrade reaction, Values of k_1 are given below

Soil Category	Value of constant k_1 Kg/cm^3
Soil Category 2	1.00
Soil Category 3	0.525
Soil Category 4	0.146

Table 1:Values of constant k_1

7.1.3 Knowing the length of the equivalent cantilever the pile head deflection (Y) shall be computed using the following equations:

$$Y = \frac{Q(L_1 + L_f)^3}{3EI}$$

……for free head pile

$$= \frac{Q(L_1+L_f)^3}{12EI}$$

……..for fixed head pile

Here,
Y in cm
Q is the lateral load in kg

7.2. Determination of Maximum Moment In The Pile

7.2.1 The fixed end moment (M_F) of the equivalent cantilever is higher than the actual maximum moment (M) of the pile. The actual maximum moment is obtained by multiplying the fixed end moment of the equivalent cantilever by a reduction factor, m given in Fig. 3. The fixed end moment of the equivalent cantilever is given by:

$M_f = Q(L_1+L_f)$ ……for free head pile

$= \frac{Q(L_1+L_f)}{2}$ ……..for fixed head pile

The actual maximum moment (M) = m (M_f)

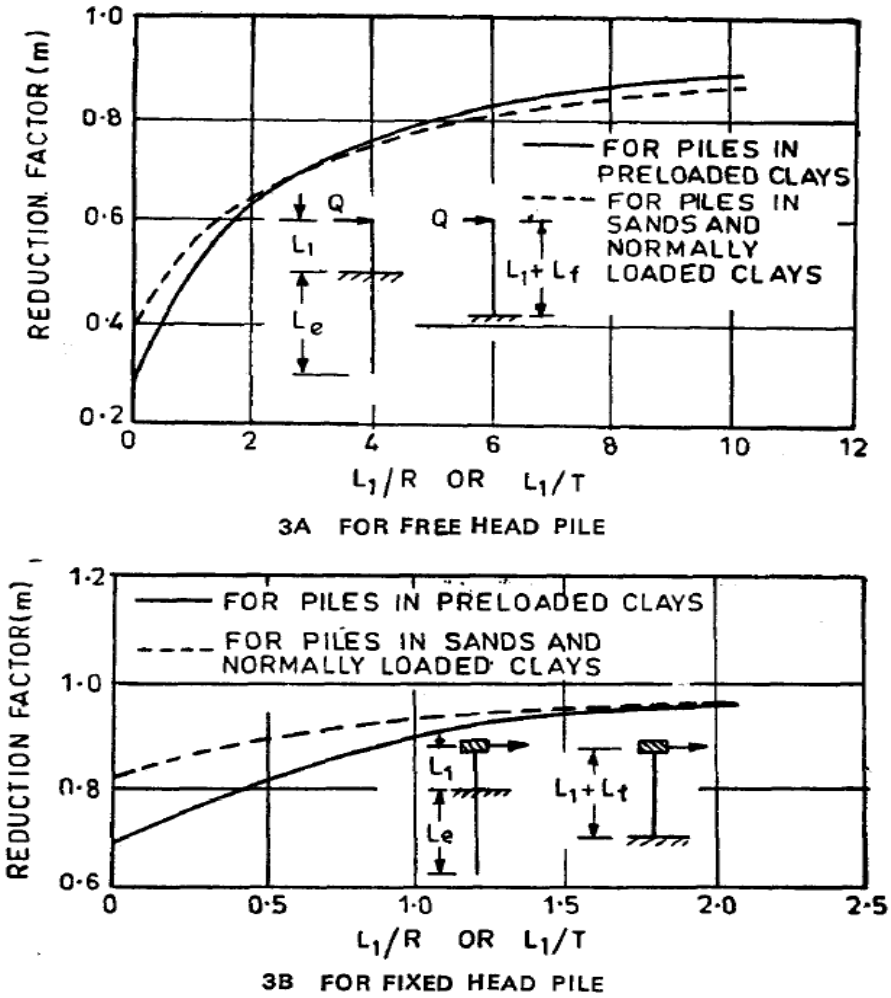


FIG.,3 DETERMINATION OF REDUCTION FACTORS FOR COMPUTATION OF MAXIMUM MOMENT IN PILE

7.2.2 Reinforcement of upper section of pile should be provided upto 1.25x L_f depth

APPENDIX 7.A6

CONCRETE MIX PARAMETERS

Grade of Concrete	Cement Type	Minimum Cement Content kg/m^3	Maximum Freewater/ cement ratio
C30	Ordinary Portland Cement (OPC) CEM I	370	0.5
C30	Portland Composite Cement (PCC) CEM II	370	0.5
C30	Sulphate Resisting Portland Cement (SRC)*	As per BSEN 197-1 CEMII/B-V	

Notes

1. Maximum nominal aggregate size 20mm.
2. For installation of drilled shaft piled foundations using bentonite slurries, minimum cement content shall be increased to 400 kg/m3
3. Slump range for cap and chimney is 50 mm to 100 mm and for pile 150 mm to 200 mm.

* If required as per soil and ground water test report.

APPENDIX 7.A7

CONCRETE COVER

Reinforcement (mm)	Stub Steelwork or Reinforcing Designed as 'Stub' Steelwork (mm)
75	**150**

APPENDIX 7.A8

Chimney & Pile Cap

(i) The top of chimney of tower foundation shall beat least 450 mm above nominal ground level for new tower design. For pre-designed towers, existing stub drawings may require to be modified in this regard.

(ii) In case of pile foundation pile cap shall be at least 450 mm below nominal ground level for new tower design. For pre-designed towers, existing stub drawings may require to be modified in this regard.

APPENDIX 7.BI

ENGINEERING DOCUMENTS TO BE SUBMITTED BY CONTRACTOR

Clause Reference	Documents Description	Comment
7.1.2	Installation Method Statement	
7.1.4.2	Drilled Shaft foundation Method Statement	
7.1.2	River Crossing Tower Foundations Method Statement	
7.4	Concrete Specification	
7.4.2	Potential Alkali Reactivity-Test Results	
7.4.4	Reinforcing Bar Couplers	
7.4.5	Spacers	Details of system
7.5.19	Working area reinstatement	Programme of work
7.6.6	Protection of Buried steelwork	Quality Control proposals
7.7.3	Reinforcement - test certificates	If requested
7.7.4	Inspection prior to concreting	Inspection record
7.7.5	Trial mixes – Test results	
7.7.6.1	Works cubes – Test results	
7.7.8	Foundation Incorrect setting,	Remedial Measure
7.7.8	Foundation Setting out-records	
7.7.9	Imported backfill – detail	
7.7.10	Foundation Tests – test proposal	
7.7.10	Foundation Tests – test results	
7.7.10	Integrity Testing – test records	If requested
7.7.14	Earth Resistance Tests – test records	
7.7.15	Protective coating – Routine tests	
7.7.15	Protection coatings – test records	If requested

APPENDIX 7.Cl

NOTIFICATION AND HOLD POINTS

Clause Reference	Notification Points	Hold Points
7.1.2		Method statement
7.1.4.2		Drilled Shaft - Method statement
7.2.3.1		Concrete Mix Design -Specification
7.4.2		Potential Alkali Reactivity
7.4.4		Reinforcing Bar Couplers
7.5.4	Use of Explosives	Use of Explosives
7.4.5	Spacers	
7.5.5		Epoxy bars site cutting
7.5.5	Straightening of bars	
7.5.13		Curing compounds
7.5.6	Concrete Trial mixes	
7.5.12	Joints	
7.6.4		Steelwork and stub-concrete Interface
7.5.17	Backfilling	
7.6.6		Protection of buried steel work
7.6.3	Epoxy Coating repair	
7.7.8		Foundation Setting remedial measure
7.7.4	Inspection prior to concreting	
7.7.10		Foundation test program
7.7.6.1	Concrete cube tests	
7.7.11		Concrete pad & chimney foundations – Design tests
7.7.12		Drilled shaft foundations tests
7.7.13	Integrity testing	Integrity testing - test proposals
7.7.14	Earth resistance tests	Earth resistance tests –Test proposals
7.7.15	Protective coating tests	Protective coating – test proposals

APPENDIX 7.DI

REFERENCE STANDARDS

The reference standards and other documents referred to in this Section of the Specification are listed below:

BS EN 197-1:	Specification for Portland cement
BS 183:	Specification for general purpose galvanised steel wire strand
BS EN 10244-2:	Specification for testing zinc coating on steel wire & for quality requirements
BS EN ISO 1461:	Specification for hot dip galvanised coatings on iron & steel articles
BS EN 12620:	Specification for aggregates from natural sources of concrete
BS EN 10083,4,5:	Specification for wrought steel for mechanical and allied engineering purposes
BS EN 10088	
BS EN 10089	
BS 1305:	Specification for batch type concrete mixers
BS 1377:	Method of tests for soils for civil engineering purposes
Part 9:	In-situ tests
BS EN 12350-1:	Testing concrete
	Method of sampling fresh concrete on site
BS EN 12390-3:	Method of determining compressive strength of concrete
BS EN 13600:	Specification for high conductivity copper tubes for electrical purposes
BS EN 1652,3,4:	Specification for rolled copper and copper alloys, sheet, strip and foil
BS EN 1057:	Specification for copper and copper alloys. Tubes
BS EN 12449	
BS EN 12163, 4,7:	Specification for wrought steel for mechanical and applied engineering purposes.
BS 3643:	ISO Metric screw threads
BS 3892:	Pulverised - fuel ash
Part 1:	Specification for pulverised - fuel ash for use Alith Portland cement
BS 4027:	Specification for sulphate - resisting Portland cement
BS 4190:	Specification for ISO metric black hexagon bolts, screws and nuts
BS 4449:	Specification for carbon steel bars for the reinforcement of concrete
BS 8666:	Specification for scheduling, dimensioning, bending & cutting of steel reinforcement for concrete
BS EN ISO 4066	
BS 4483:	Specification for steel fabric for the reinforcement of concrete
BS 8500-1,2:	Concrete
BS EN 206-1	Guide to specifying, concrete
	Methods for specifying concrete mixes
	Specification for the procedure to be used in producing, and transporting concrete
	Specification for the procedure to be used in sampling, testing and assessing compliance of concrete
BS 7079	Visual Assessment of surface cleanliness
Part A1	Specification rust grades and preparation grades of uncoated steel substrates and steel substrates after overall removal of previous coatings.
BS ISO 14654:	Fusion bonded epoxy coated carbon steel bars for the reinforcement of concrete
	Specification for coated bars
BS ISO 14656:	Specification for coatings
BS 7884:	Specification for copper and copper cadmium stranded conductors for overhead electric traction and power transmission systems.
BS 8004:	Code of practice for foundations
BS 8081:	Code of practice for ground anchorage
BS EN 1537	
BS 8110:	Structural use of concrete

Part 1:	Code of practice for design and construction
BS EN 10025:	Specification for hot rolled products of non-alloyed structural steels and their technical delivery requirements
ASTM C33:	Specification for concrete aggregates
ASTM C227:	Standard Test Method for Potential Alkali Reactivity of cement/aggregate combinations (Mortar bar method)
ASTM C289:	Standard Test Method for Potential Alkali Silica Reactivity of Aggregates (chemical method)
IEC 61773:	Overhead lines – Testing of foundations for structures

ANNEXURE - B

PILE DATA SHEET

1. Reference No. Location (Co-ordinates)_____ area.

2. Sequence of Piling

3. Pile diameter & Type

4. Working level (Platform level)

5. Cut off level (COL)

6. Actual length below COL

7. Pile termination level

8. Top of finished concrete level

9. Date and time of start and completion of boring

10. Depth of Ground water table in the vicinity

11. Type of strata at pile tip

12. Method of boring operation

13. Details of drilling mud as used :

i) Freshly supplied mud

liquid limit
sand content
density
marsh viscosity
Swelling index
pH value

ii) Contaminated mud
density
sand content

14. SPT, N values in soil (from the nearest bore hole). UCS value in rock (from the nearest bore hole).

15. Chiseling if any, from....m to.....m.

16. Date and time of start and completion of concreting

17. Method of placing concrete

18. Concrete quantity :

    Actual
    Theoretical

19. Ref. Number of test cubes

20. Grade and slump of concrete

21. Results of test cubes

22. Reinforcement details :

Main Reinforcement	Stirrups : Type
No._____	No._____
Dia_____	Dia_____
Depth_____	Spacing_____

23. Any other information regarding constructions, delay and other interruption to the sequence of work.

NOTE : The above details are required to be furnished by the Contractor before starting the installation work.

8. Towers

8.1 Scope

8.1.1. The scope includes design, testing, fabrication, supply and erection of towers on the basis of tender specification. Requirement of tower design, whether new design require or earlier designed tower will be used, is specified in the **Annex**.

8.1.2 In case the proto type load tested or earlier designed towers and poles are used then the Employer shall provide structural/erection drawings, available shop drawings, and bill of materials of towers, poles and their extensions as required to the Contractor after placement of award, in sequence, suiting the project requirement, upon written request of the Contractor. The Contractor has to satisfy themselves regarding correctness of the available drawings.

8.1.3 Regarding the proto type load tested or earlier designed towers, if the Contractor needs to prepare any additional structural and shop drawings or make any correction of existing drawings, that have to be prepared by the Contractor without any additional cost. In such case, the Contractor has to submit relevant documents/drawings for approval of the Employer.

8.1.4 In case the proto type load tested or earlier designed towers and poles are used then the Bidders are requested to inspect the available drawings in the Design Dept. of Power Grid Bangladesh to satisfy them regarding the extent of available drawings. Bidders are required to propose the tower/pole materials from a manufacturer who will use the same material standard as mentioned in the drawings.

8.1.1 Classes of Towers

Reference shall be made to **Annex 8-2** for the classes of tower required.

8.1.2 Designation of Tower Types

Reference shall be made to **Annex 8-3** for the designation and use of the different tower types.

8.1.3 Standard Height Towers

All standard height towers are those designed to support the conductors at the defined clearance above designated ground under the specified ultimate limit state system loading assuming such towers are at the same level on level ground and at the standard span apart. The Standard span length is shown in **Annex 8-5**.

Unless specified to the contrary, after taking account of the length of the insulator set all standard height towers shall be arranged so that the point of attachment or suspension of the phase conductors above the ground shall be the same for all tower types.

8.1.4 Extensions

8.1.4.1 Where specified each type of tower shall be designed to allow for variations in height. Towers with any specified combination of extensions to the standard height tower, shall be capable of

carrying all required phase conductors, earthwires, insulator sets and fittings under the specified system loading.

8.1.4.2 Reference shall be made to the **Annex 8-4** for the range and type of extensions required. Tower with different leg extensions shall be used as per requirement of the route.

8.1.4.3 Where individual leg extensions are specified for lattice steel towers they shall be directly inter-connectable and fully compatible with the basic tower body and all specified body extensions.

8.1.5 Span Criteria

8.1.5.1 The span lengths specified in **Annex 8-5** shall be deemed to be the horizontal distance between centrelines of adjacent support. When a span in excess of the specified maximum span is unavoidable, advice on the application should be obtained from the Engineer.

8.1.5.2 All angle towers when used with the corresponding maximum angles of deviation and all intermediate type towers shall be used so that the sum of the two adjacent spans stated in **Annex 8-5** is not exceeded, provided that no single span length exceeds the specified maximum. Designs shall allow for the adjacent spans of the maximum specified length with one of the spans at the maximum allowed for a single span.

8.1.5.3 Section type tower may be used at straight line positions where necessary for uplift conditions or for sectioning and tensioning of the phase conductors and earthwires in a straight run of transmission line route.

8.1.5.4 Angle towers shall be suitable for minimum weight spans combined with maximum wind span through the full angular range of line deviations for which the angle towers are designed.

8.1.6 Minimum Conductor Weight at Intermediate Tower

The total weight supported by any intermediate tower suspension insulator set shall not be less than the specified (see **Annex 8-5**) weight of the corresponding phase conductors in the two adjacent spans. This condition shall apply under the specified loading conditions.

8.1.7 Angle Towers

For angle towers at the mean angle of deviation, the mean horizontal separation between circuits shall not be less than that of an intermediate type support.

For bundled phase conductors the phase conductor attachment points on each crossarm/gantry shall be arranged to ensure that the nominal horizontal separation between sub-conductors at the tension joint (dead end), is not reduced by more than 25 mm.

8.1.8 Terminal Towers

Terminal towers shall provide the corresponding separation at the specified line entry. Additional phase conductor attachment points shall be provided at the specified angles of entry. Additional crossarms for down-leads or for use in junction arrangements with full phase tension shall be provided when specified.

8.2 Design

8.2.1 General

8.2.1.1. Towers shall have the general arrangements and configurations shown in the drawings included with the Specification. They shall be designed to resist the specified system loading taking into consideration the required strength coordination factors. Clearances between live parts and supporting steelwork and between the phase conductors and ground or other obstacles shall be as specified.

8.2.1.2. All tower designs shall be such as to facilitate inspection, painting, maintenance, repairs and operation with the continuity of supply being the prime consideration.

8.2.1.3. The design shall be such that the number of different parts shall be as few as possible to facilitate transport, erection and inspection. The maximum weight of the heaviest single member should be limited to that within the normal lifting capability of the proposed erection equipment.

8.2.1.4. Main leg members of lattice steel towers shall be formed of the maximum single lengths appropriate to the body or leg extensions, and shall not without the Engineer's approval, incorporate additional spliced sections.

8.2.1.5. For lattice steel towers a fully triangulated system of bracings shall preferably be adopted. If full triangulation is not adopted, the overall stability and secondary bending, stresses must be considered in the design.

8.2.1.6. Where fabrication processes employed adversely affect the material properties, or introduce zones of high stress concentration the overall design of the structures shall take such factors into account.

8.2.1.7. Crossarms shall be so arranged that they can be disconnected in the plane of the longitudinal face of the tower without disturbing any members forming part of the tower body.

8.2.1.8. All panels below the proto type test tower height must be of K-braced type.

8.2.2 Attachments to Towers

The attachment of phase conductors, earthwires and erection/maintenance brackets shall be undertaken as follows:

(a) Intermediate Lattice Steel Towers

i) Suspension insulator set and earthwire attachments shall be of an approved swivel or shackle arrangement;
ii) Adjacent to and either side of all suspension insulators set attachment points, additional maintenance points shall be provided, capable of resisting the specified construction and maintenance (C&M) load;
iii) Adjacent to the earthwire suspension set attachment point, an additional maintenance point shall be provided, capable of resisting the specified C&M load;

iv) At each tower body crossarm connection point (bottom chord level) maintenance plates /brackets shall be provided for the attachment of rigging blocks, capable of resisting the specified C&M load;
v) Where it is proposed to erect complete sections of the tower by crane or helicopter then permanent lifting points shall be provided.

(b) Angle/Tension Lattice Steel Tower

i) Tension insulator set attachments shall be of an approved swivel or shackle arrangement;
ii) Adjacent to and either side of all tension insulator set attachment points, additional maintenance points shall be provided, capable of resisting the specified C&M loading. The additional maintenance points shall provide the necessary mountings for stringing and maintenance equipment;
iii) Adjacent to all tension insulator set attachment points, a vertical maintenance attachment point shall be provided, capable of resisting either the specified C&M loads or that imposed by the use of a conductor stringing platform;
iv) Adjacent to the earthwire tension set attachment point, an additional maintenance point shall be provided, capable of resisting the specified C&M loads;
v) At each tower body crossarm connection point (bottom chord level) maintenance plates / brackets shall be provided for the attachment of rigging, blocks, capable of resisting the specified C&M loads.

(c) River Crossing Towers

i) Suspension insulator set and earthwire attachments shall be of an approved swivel or shackle arrangement;
ii) Adjacent to and either side of all suspension insulators set attachment points, additional maintenance points shall be provided, capable of resisting the specified construction and maintenance (C&M) load;
iii) Adjacent to the earthwire suspension set attachment point, an additional maintenance point shall be provided, capable of resisting the specified C&M load;
iv) At each tower body crossarm connection point (bottom chord level) maintenance plates /brackets shall be provided for the attachment of rigging blocks, capable of resisting the specified C&M load;
v) Where it is proposed to erect complete sections of the tower by crane or helicopter then permanent lifting points shall be provided.

(d) Anchor Tower

i) Tension insulator set attachments shall be of an approved swivel or shackle arrangement;
ii) Adjacent to and either side of all tension insulator set attachment points, additional maintenance points shall be provided, capable of resisting the specified C&M loading. The additional maintenance points shall provide the necessary mountings for stringing and maintenance equipment;
iii) Adjacent to all tension insulator set attachment points, a vertical maintenance attachment point shall be provided, capable of resisting either the specified C&M loads or that imposed by the use of a conductor stringing platform;
iv) Adjacent to the earthwire tension set attachment point, an additional maintenance point shall be provided, capable of resisting the specified C&M loads;
v) At each tower body crossarm connection point (bottom chord level) maintenance plates /brackets shall be provided for the attachment of rigging blocks, capable of resisting the specified C&M loads.

All tower general arrangement drawings and/or erection diagrams shall clearly indicate the safe working, load capacities of all maintenance points.

8.2.3 Stubs

Stubs for the standard height tower, tower body and leg extensions shall be of the same design. Unless specified to the contrary only one design of stub shall be permitted for each type of tower and the stubs shall be identical for all four legs. Two different type of stub design may require for rigid frame foundation and pile foundation. No extra payments shall be made for such two type of stub. For details of the cleat design, reference shall be made to 'Foundations' Section.

The size of stub leg members shall not be less than the corresponding connecting tower leg members.

8.2.4 Design Criteria

Unless otherwise mentioned in the bidding documents, tower structural loading shall be in accordance with ASCE 74-2009 and tower design shall be in accordance with ASCE 10-97/ASCE 10-15.

Loading Conditions	Wind Speed	Coincident Temperature	Design Aspect
Normal Condition (DL)	50% of FL	50˚C	Electrical Clearance of structure (PFC)
Normal Condition (DL)	15.6 m/s	50˚C	Electrical Clearance of structure (LIC)
Normal Condition (DL)	100% of FL	5˚C	Structure design
High Intensity Wind Condition	100% of FL	5˚C	
Security Condition	50% of FL	5˚C	
Safety condition	15.6 m/s	5˚C	

Note: DL - Damage Limit, FL - Failure Limit, PFC - Power Frequency Clearance, LIC - Lighting Impulse Clearance.

Wind speed (Failure Limit), weather load factor and exposure category shall be considered as mentioned in **Annex 8-1.**

8.2.5 Load Case and Load Combination

8.2.5.1 Reliability Load Cases

Reliability load cases shall be applied to structure to design up to the failure limit (FL). The conductor shall be considered under "creep" condition.

8.2.5.1.1 Normal Conditions

The towers shall be designed for the following loads considered to be applicable simultaneously.

a) Vertical Loads

Dead weight of tower, weight of insulators and all other fittings, actual dead weight of conductor, earthwire and OPGW of specified weight span lengths in **Annex 8-5**. V_{max} for maximum weight span with following load factor and V_{min} for minimum weight span with following load factor shall be considered.

Description	Load Factor
Maximum weight span	1.25
Minimum weight span	0.9

b) Transverse Loads

Transverse load due to wind (wind angle 0°, 22.5°, 45°, 67.5° and 90°) on earthwire/OPGW, conductor, tower members, insulator and all other fittings and transverse component of maximum working tension of earthwire/OPGW & conductor due to maximum horizontal deviation angle of line. Load factor for horizontal tension of earthwire/OPGW & conductor shall be considered 1.25.

c) Longitudinal Loads

For suspension towers 3% and for angle towers 10% of conductor or earthwire/OPGW ultimate tensile strength shall be considered as unbalanced longitudinal load. For terminal tower, maximum working tension of conductor shall be considered as unbalanced longitudinal load. Load factor for conductor tension shall be 1.25.

8.2.5.1.2 Special Normal Condition

a) Eccentric Loads

Towers shall be checked for eccentric loading caused by the conductors and earthwire/OPGW strung on one side of the tower. In checking the tower for this kind of loading the loads mentioned above for vertical, transverse and longitudinal loads shall be considered for three phase conductors and earthwire/OPGW on one side of the tower in addition to wind on tower and weight of tower.

For terminal towers, torsion loads caused by the unbalanced longitudinal working tension due to one circuit conductors and earthwire/OPGW strung shall be considered.

Same load factors mentioned above for Normal Condition shall be applicable for Eccentric Loads also.

b) High Intensity Local Wind Loadings

High intensity local wind is required to be considered by applying wind at 0°, 22.5°, 45°, 67.5° and 90° on tower body. A load factor of 2.0 on wind pressure is required to be considered for this case. It shall be assumed that there is no wind on conductor.

8.2.5.2 Security Loading

The towers shall be designed for the following loads considered to be applicable simultaneously.

a) Vertical Loads

Dead weight of tower, weight of insulators and all other fittings, actual dead weight of conductor, earthwire and OPGW of specified weight span lengths in **Annex 8-5.**V_{max} for maximum weight span with following load factor and V_{min} for minimum weight span with following load factor shall be considered.

Description	Load Factor
Maximum weight span	1.25
Minimum weight span	0.9

b) Transverse Loads

Transverse load due to wind (50% of Failure Limit wind at angle 0°) on earthwire/OPGW, conductor, tower members, insulator and all other fittings and transverse component of maximum working tension of earthwire/OPGW & conductor due to maximum horizontal deviation angle of line. Load factor for horizontal tension of earthwire/OPGW & conductor shall be considered 1.25.

c) Longitudinal Loads

For intact point, unbalanced tension is similar to normal condition.

For broken point, unbalanced longitudinal tension shall be considered as per criteria given below:

<table>
<tr><th>Tower Type</th><th>Conductor Tension</th><th colspan="2">Residual Static Load Factor</th><th>Load Factor</th><th>Broken Wire Assumption</th></tr>
<tr><td rowspan="4">Suspension/ Heavy suspension</td><td rowspan="5">Conductor tension at security condition</td><td>String Length</td><td>Factor</td><td rowspan="4">1.25</td><td rowspan="4">1 earthwire or 1 phase (all sub-phase) is broken</td></tr>
<tr><td>< 1m</td><td>1.0</td></tr>
<tr><td>1m< but < 2m</td><td>0.7</td></tr>
<tr><td>> 2m</td><td>0.6</td></tr>
<tr><td>Angle tower</td><td colspan="2">1.0</td><td>1.25</td><td>1 earthwire and 1 phase (all sub-phase) or 2 phase broken (all sub-phase) on the same side are broken</td></tr>
</table>

8.2.5.3 Safety Loading

a) Structure Erection

The specified construction and maintenance loading shall be applied to all phase conductor and earthwire/OPGW attachment points in the combinations stated.

Where appropriate that loading and/or their individual components shall also be applied to the corresponding maintenance points e.g. the vertical component shall be applied to vertical maintenance attachment points, whilst the longitudinal is distributed to the horizontal maintenance plates.

All members with an inclination of 40 degrees to 90 degrees to the vertical, shall be checked for the effects of point loading of 1.5kN at its most onerous position. No other loading shall be considered under this condition.

It is the Contractor's responsibility to consider all constructional loading due to his proposed method of tower erection and conductor stringing. Where necessary, any additional loading due to these methods shall be considered in the design of the tower and especially the specified maintenance, lifting or attachment points. Under these conditions a minimum load factor of 1.5 shall be considered.

b) Ground Wire and Conductor Installation (Stringing)

1. Only angle and sections towers shall be subjected to this load.
2. For transverse and vertical loads, wind (15.6 m/s) on the wires and structure shall be considered. Use the lowest temperature (5° C) that can be expected to occur during stringing operations.
3. The towers shall be designed for square rigging load assuming stringing tension working vertically and longitudinally simultaneously at the crossarm tip.
4. For transverse wind loads, maximum design wind span with a load factor of 1.0 shall be considered.
5. Longitudinal and vertical load factor shall be 2.0 for phase under stringing operation; this factor shall be 1.5 for strung phases.

Different load cases shall be considered based on sequence of stringing.

c) Fall Protection Loads

Two person's fall arrest factored impact loading (21kN) at any crossarm tip point shall be considered. Simultaneous vertical load due to conductor and loads due to conductor tension shall have load factor 2.0.

In other attachment points load factor 1.5 shall be considered on conductor tension and vertical load.

d) Dropped conductor

In this case weight span shall be considered 1.5 times of maximum weight span with a load factor of 1.5 for all loads at that attachment point. In other attachment points load factor 1.5 shall be considered on conductor tension and vertical load.

8.2.6 Downlead Tensions

The maximum downlead tension shall be as specified in **Annex 8-6**. However, for the purpose of tower design they shall be assumed to be zero except where the vertical load component increases the stresses in tower members. These tensions shall be assumed to apply at both ends on low duty tension insulator sets.

8.2.7 Down Droppers to Substation Equipment

The design of down droppers shall take into account the limiting strength of substation equipment specified in **Annex 8-6**.

8.2.8 Allowable Ultimate Unit Stresses

The allowable ultimate unit stresses used in the determination of the nominal strength of support members shall be based on the following criteria:

a) For lattice steel tower shall be based on the recommendations contained in BS 8100-3 or ANSI /ASCE Std. 10-15. For ANSI/ASCE Std. 10-15 the appropriate reference stress levels shall be based on the values specified in BS 5950, and as summarized below:

Grade	Reference Stress Level(N/mm²)	Nominal Thickness
S235JRG2	235	≤ 16 mm
	225	> 16 ≤ 40mm
S275JR	275	≤ 16mm
	265	> 16 ≤ 40mm
S355JO	355	≤16mm
	345	> 16 ≤ 40mm

b) For lattice steel tower where the appropriate design stresses are not contained in the specified code of practice/manual, reference shall be made to BS 5950.

8.2.9 Member Design Criteria

8.2.9.1 The maximum allowable slenderness ratios for members of lattice steel towers shall be

- For leg members, crossarm chords 120
- For other load-bearing compression members 200
- For secondary bracings 250
- For tension only members 350
- For angles with slenderness ratios measured about their x-x and/or y-y axis 200

8.2.9.2 Secondary bracings shall be designed in accordance with the requirements of BS 8100-3.

8.2.9.3 Members shall be of such size, shape and length as to preclude damage or failure from vibration or stress reversal, including the detailing of the connections.

8.2.9.4 The minimum angle between main members and diagonal members as well as between bottom and upper member of crossarms shall be 15°.

8.2.9.5 The minimum thickness and diameter of material used in members and bolts shall be in accordance with the requirements of **Annex 8-7**.

8.2.10 Bolted Joints

8.2.10.1. Where appropriate all metal parts shall be secured with bolts and nuts with single spring washers. All nuts and bolts shall be in accordance with clause 8.3.3 unless specified to the contrary.

8.2.10.2. When in position all bolts shall project through the corresponding nuts by at least three threads for brazing, but such projections shall not exceed 10 mm. No screwed threads shall form part of a shearing plane between members.

8.2.10.3. The nuts of all bolts attaching phase conductor insulator sets, earthwire sets, maintenance brackets/plates, access ladder brackets, fall arrest system attachment brackets shall be locked in an approved manner preferably by locknuts.

8.2.10.4. The diameter of bolts used for towers shall be as mentioned in **Annex 8-7**for new design. For existing design, bolt sizes are mentioned in the relevant approved design drawings.

8.2.10.5. The bolts of any one diameter in a tower shall be one grade of steel.

8.2.10.6. Leg members shall be joined in such a way that electrical continuity is maintained to ground.

8.2.11 Electrical Clearances - Live Metal and Earthed Steelworks

Minimum clearance between live metal and earthed steelwork shall be in accordance with the requirements of **Annex 8-9**.

8.2.12 Downlead Clearances

The clearance in still-air between down leads shall be in accordance with the requirements of **Annex 8-9**. In exceptional circumstances and with the approval of the Engineer, under conditions of maximum (opposing) conductor swing and sag, the clearance may be reduced to the values specified in **Annex 8-9**.

8.2.13 Anti-Climbing Devices

8.2.13.1. Each support shall be fitted with an approved type of anti-climbing device as specified in **Annex 8-10**. The height of the anti-climbing device shall be adjustable and shall be within the limits specified in the **Annex 8-10**.

8.2.13.2. Where specified the anti-climbing device shall be provided with a hinged section where access for personnel is required. The hinged section shall be capable of being bolted and locked in the closed position with either a bolt, nut and locknut or a padlock. In the open position, no projection to impede safe access shall be permitted.

8.2.13.3. In no case shall an anti-climbing device be installed where it can be bypassed from a side slope or internal bracing.

8.2.13.4. Barbed wire type anti-climbing devices shall comply with the following requirements:

(a) Barbed wire shall be of the mild steel type with high security long barbs 15 mm long set at 50 mm spacing, but in all other respects the barbed wire shall comply with BS 4102, Section 4;
(b) For lattice steel towers the minimum distance between strands or between strands and horizontal tower member/pole sections shall not be less than 150 mm;
(c) No unprotected space greater than 230 mm across shall be left inside the device;
(d) Spacers shall be fitted at 1.5 m intervals and shall be attached to tower members where possible;
(e) Normally 5 strands of barbed wire are required outside the tower face and 3 strands inside;

8.2.13.5. Spiked type anti-climbing devices shall comply with the following requirements:

(a) The minimum spike diameter shall not be less than 10 mm, and shall project horizontally 50 mm and curve vertically down by 40 mm.
(b) Where spikes are bolted to the support frame the spike threads must be clenched after installation.

8.2.14 Livestock Guards

8.2.14.1 Means shall be provided on all lattice steel towers and tower extensions to avoid the risk of livestock being caught between tower members and being injured.

8.2.14.2 Tower members near the around shall be sufficiently robust to avoid being damaged by livestock. To enable supplementary livestock guards to be added, spare holes, normally 17.5 mm diameter and 300 mm apart, shall be provided on each face of the main leg members and the appropriate faces of bracing members, for a distance of approximately 1200 mm from ground level.

8.2.15 Bird Guards

Where specified bird guards of an approved type shall be fitted to intermediate towers fitted with suspension insulator sets. The bird guard shall either comprise a saw-tooth plate, or a length of earthwire/OPGW suitably de-stranded and splayed out at each end and clamped to the cross arm member.

8.2.16 Bird Flight Diverters/Flappers

The bird flight diverters/flappers of an approved type shall be installed on the line (earth-wire / OPGW or/and phase wires) for a length of 500m either side of the river crossings or large waterbodies and any additional locations required by Environmental study (Avian protection plan) and IEE. Bird divertors shall be spaced at 10m intervals. The bird divertors must be an internationally accepted, robust design of contrasting colour, that reflects UV light, glows in the dark, and guaranteed for at least 5 years.

8.2.17 Access Facilities

Each support shall be fitted with approved access facilities as specified in **Annex 8-10**. The following requirements for specific types of access facilities shall apply as appropriate.

a) Step Bolts

i) Step bolts shall be fitted between specified levels at 380 mm spacing;
ii) On double circuit towers they shall be fitted on the right hand leg on both transverse faces; for single circuit towers they shall be fitted on the right hand leg on one transverse face;
iii) The first step bolt below each cross arm or gantry shall be located on the transverse face of the leg, and all remaining step bolts shall be fitted, alternatively on the remaining of the support;
iv) On terminal and junction towers, provision shall be made for fitting of step bolts on all legs;
v) Step bolts shall not be less than 16 mm diameters, fitted with nut, washer and nut and shall project not less than 200 mm from the support when fitted;
vi) For steel poles, removable step bolts or step brackets in accordance with the requirements of (v) shall be fitted. The step bolt brackets shall be permanently attached to the pole;
vii) Where support legs are fabricated from solid round sections, clamp type steps shall be provided at similar spaces and projection as step bolts.

b) Ladders

i) Ladders shall be fitted between specified levels, support faces and either externally or internally;
ii) Ladders shall be in accordance with BS 4211, 350 mm between internal faces and 300 mm rung spacing;

iii) Rest platforms shall where specified be fitted at approximately 10m height increments with the rest platform 850 mm x 850 mm square and fitted with a guard rail (1000 mm above the platform), intermediate rail and toe board (projecting 100 mm);
iv) Ladders shall project 1100mm above platforms, unless other hand holds are provided and shall be between 150 to 230 mm from the platform where side access to the platform is provided.

c) Fall Arrest Systems

i) Fall arrest system shall be in accordance with the requirements of BS EN 360;
ii) The system shall be either a guided type fall arrester on a rigid anchorage line to BS EN 353-1, or a guided type fall arrester on a flexible anchorage line to BS EN 353-2.

d) Work Platforms

i) Work platforms shall be provided with hand rails as detailed in clause (b) iii);
ii) Platforms shall be designed for a transient load of 1.5 kN vertically concentrated load over any square with a 300 mm side, plus a 1.5 kN/m² vertically distributed load applied simultaneously to produce the worst loading condition.
iii) Flooring for platforms shall be the open type metal in accordance with BS 4592 and BS EN ISO 14122-1 to 3.

8.2.18 Danger and Identification Plates

All towers shall be fitted with danger and identification plates as specified in **Annex 8-10**.

8.2.19 Earthwire Bonding

8.2.18.1 Attachment holes for the connection of earthwire bonds shall be provided adjacent to the earthwire attachment point.

8.2.20 Earthing of Towers

8.2.19.1 Attachment holes for the connection of the ground earthing conductor shall be provided on all lattice towers standard heights adjacent to the stub connection, leg and body extension and cleats of stubs.

8.2.19.2 The maximum value of the earthing resistance shall be as mentioned in 'Foundation' Section.

8.2.19.3 The Contractor shall undertake preliminary soil resistivity measurements along each line route as soon as possible after award of the contract. The number and location of test points as well as the testing method shall be agreed with the Engineer.

8.2.19.4 In the presence of the Engineer, the Contractor shall measure the electrical footing resistance to earth of each tower before earth conductors are erected. These measurements shall be recorded by the Contractor in the form of a tower footing earth resistance profile of an approved type.

8.2.20.5 The following materials or their equivalents shall be used:

(i) Steel earthing rods shall be clad with 99.9 percent electrolytic pure copper molecularly bonded to the steel, with a minimum thickness of 0.35 mm. The earthing conductor at the ground interface and at the connection to the tower shall be protected against corrosion.

(ii) Minimum length of earthing rods shall be 3m. Provisions shall be made for coupling the rods to extend their length, if necessary. A bronze or brass bolted clamp shall be provided for connecting the earthing cables to the earthing rods.

(iii) Earthing cables (counterpoise), made of galvanised steel wire, with a diameter of 12 mm.

(iv) Connection of the counterpoise to the tower steelwork to be made by means of a compressed lug and two galvanized bolts and nuts, washers and spring washer on the tower stub at least 500 mm above the foundation surface. The minimum diameter of the bolts shall be 12 mm. The holes in the leg/stub steelwork shall be factory drilled prior to galvanizing.

(v) All mild steel used in the manufacture of earthing rods shall comply with the requirements of BS EN 10083 etc.: (minimum strength 600 N/m).

(vi) Phosphor-bronze used in the manufacture of earthing rod couplings shall comply with the requirements of BS 12163 etc.

(vii) All compression fittings shall be manufactured from electrolytic tough pitch high conductivity copper, complying with the requirements of BS 13600 and BS EN 1057 and 12449, designation C101.

(viii) Earthing conductors shall be in accordance with the following requirements:

e. Copper strip to BS EN 1652, 1653 and 1654, Grade C101 or C102, minimum cross sectional dimensions 20 mm x 3 mm;
f. Hard drawn copper strand to BS 7884, minimum overall diameter 10.65 (7 x 3.55 mm);
g. Galvanized steel wire to BS 183, minimum overall diameter 12 mm (7 x 4.00 mm).

The depths of the upper ends of earthing rods and the depth of buried earthing cables shall not be less than the following values:

- Cultivated (soft) soil: 800 mm
- Normal soil: 500 mm
- Rocky ground: 150 mm

Where the measured tower footing resistance is higher than the value mentioned in 'Foundation' Section, towers shall be earthed using one of the systems detailed below:

Earthing for Normal Soil (Type A, B and C)

Type A

- Each tower shall be earthed at two diagonally opposed legs. The earthing rods, one per leg, shall be hammered vertically into the soil to a depth of 3m at a minimum distance of 5m from the footing, and shall be connected to the tower legs by earthing counterpoise cables.
- This type of earthing system shall be generally used where ground conditions are favourable, i.e. in cultivated (or soft) soil.

Type B

- Installation of earthing rods as described for Type A, but with one 3m rod and earthing counterpoise cable connected to each tower leg.
- This type of earthing system shall be used in cultivated (soft) soil where Type A earthing does not provide adequate earthing.

Type C

- Installation of earthing rods as described for Type A, but with each rod being extended to a length of 6m and an earthing counterpoise cable connected to each tower leg.
- This earthing system shall generally be used where ground conditions are not favourable but not rocky.

Earthing for Rocky Ground (Type A, B and C)

This type of earthing system shall generally be used in rocky grounds.

- 30m of earthing counterpoise shall be laid to the edge of the servitude, then in parallel to the line from both sides of the tower. The cable shall be buried at the specified minimum depths and shall be clamped at two diagonally opposite corners of the tower to the corresponding stub as detailed above. This will be classed as Type A.
- Two additional 30m long earthing counterpoise cables connected to the first lengths shall be Type B.
- Another two additional 30m cables will be Type C.

Type D

- Any special measure and method (deep grounding, counterpoise connection to the adjacent tower, earth conductivity improving chemicals etc.), subject to approval of the Engineer, shall be used in specific soils where Type C earthing cannot provide sufficient resistance reduction.

- For all earthing system types, each earthing cable section shall be separately bolted to the tower so that it can be disconnected for the purpose of earth resistance measurements, if required.
- At each tower connected to an earthing system, the Contractor shall measure the electrical footing resistance to earth with the system connected. The measurements shall also be recorded by the Contractor in the tower footing earth resistance profile.
- The terminal towers shall be connected to the substation earthing grid.
- Type and thickness of galvanizing shall provide sufficient protection of steel for 20 years of service and shall not be less than 610 g/mm².
- Metal roofs of existing buildings constructed within 30m of the centre of the transmission line shall be securely earthed. A minimum of two earth connections shall be made to opposite sides of the roofs by means of earthing (counterpoise) cable, which shall be led down the sides of the building to earth. The earthing cable shall be securely fixed in cleats to the sides of the buildings and not less than 2m of the cable shall be buried in the ground at a depth of at least 800 mm.
- All metallic fences, new and existing, which cross under or are located near or parallel to the transmission line shall be earthed as follows:
  - One earthing rod shall be used to ground each 100m of fence that is parallel to and within 50m of the centre line of the transmission line.
  - One earthing rod shall be used on each side of the right of way to earth fences crossing under the line.
  - Earthing rods, to which the fence wires shall be bonded, shall be driven to a depth of not less than 1.5m.
  - All metallic fence gates within the right of way shall be electrically bonded to the fences.

8.2.21 Design Calculations

The Contractor shall submit the following design calculations to the Engineer:

a) wire clearance diagram;
b) line diagram;
c) tower design calculations (in an approved format) indicating the applied loading along with calculation, loading tree, body wind load calculation, the design load for each member under the critical loading case, member size, slenderness ratio, allowable load and end connection details;
d) when requested the load for each member for each loading case shall be made available;
e) foundation load schedule;
f) wire clearance diagrams for each terminal and junction position.

The Contractor shall not proceed with any tower prototype test until after the approval of the design calculation. **This is a Hold Point.**

The tower shall be designed using PLS-Tower software. The Contractor is required to submit PLS-Tower backup along with hard copy of the design report.

8.2.22 Fabrication Drawings

8.2.21.1. The Contractor shall submit the following fabrication drawings to the Engineer;

a) Panel assembly (fabrication) drawings;
b) Erection drawings;
c) Stub setting diagrams;
d) Stub, anchor bolt assembly.

8.2.21.2. Panel assembly drawings shall show all material in place, complete with all fabrication and connection details. A complete tabulation listing all pieces for the portion of the support detailed shall be shown on each drawing.

8.2.21.3. Each erection diagram shall show one support panel, together with a key diagram indicating its location on the complete support. Each piece shall be identified by its mark number. The number and length of bolts and number and type of nuts and washers required for proper assembly shall be shown at each connection. A complete tabulation listing all the material needed for the support panel including all bolts, nuts, fill and bevel washers and locknuts, shall be shown on each drawing. The tabulation shall show the quantity, the mark number, the description of the piece (including size and length), the total mass (including the allowance of 3.5% additional mass for galvanising) to the nearest 0.1 kg of all the pieces of the same mark, and the number of the drawing on which the shop detail of the piece can be found. The quantities including 5% excess of step bolts, bolts, nuts, fill and bevel washers, and locknuts shall be shown.

8.2.21.4. The Contractor shall make all changes to the detail (fabrication) and the erection drawings which the Engineer determines necessary to make the finished support fabrication conform to the requirements and intent of this specification. The Contractor shall not proceed with any fabrication until after the submission of the fabrication drawings. **This is a Hold Point.**

8.2.21.5 The Contractor shall submit scanned copy of approved erection/structural drawings of each tower for record purpose after the successful test.

8.2.21.6 The Contractor shall submit hardcopy of shop drawings of each tower extension-wise along with AutoCAD soft copy for record purpose after the successful test.

8.2.21.7 The Contractor shall submit hardcopy of bill of material of each tower extension-wise along with editable soft copy for record purpose after the successful proto test.

8.2.21.8 In case of existing pre-designed towers, if the drawings/documents mentioned above are not available and/or incomplete and/or correct, then the Contractor shall develop and submit such drawings/documents for approval. They will submit hardcopy and soft copy (scanned for approved copy) along with editable soft copy for record purpose after the successful proto test.

8.2.23 Cradle Guards

Not Applicable.

8.3 Materials

8.3.1 Steel

8.3.1.1. All steel shall comply with BS EN 10025 or BS EN 10210 as appropriate and shall be suitable for all the usual fabrication processes, including hot and cold working within the specified ranges.

8.3.1.2. The quality of finished steel shall be in accordance with BS EN 10163. All steel shall be free from blisters, scale, laminations, segregation and other defects. There shall be no rolling laps at toes of angles or rolled-in mill scale.

8.3.1.3. The following grades of steel shall be applicable :

a) Mild steel shall be either grade S235JRG2 or S275JR.
b) High tensile steel shall be grade S355JO

8.3.1.4. Steel section profiles shall be in accordance with the requirements of BS 4: Part 1, BS EN 10210-2, BS EN 10056-1, BS EN 10024, BS EN 10034 and BS EN 10056-2 as appropriate.

8.3.1.5. Hot rolled steel plate, 3 mm thick or more, shall be in accordance with the requirements of BS EN 10029.

8.3.2 Malleable Cast Iron

Malleable cast iron shall be in accordance with the requirements of BS EN 1562 for white heart or pearlite and BS EN 1563 for spheroidal graphite .

8.3.3 Bolts, Nuts, Clevis Pins and Washers

8.3.3.1. Unless specified to the contrary the following grades of steel shall be applicable :

a) Material quality of bolts of 12 mm diameter shall be Grade 4.6 according to ISO 898
b) Material quality of bolts and clevis pins of 16 mm diameter and over shall be Grade 5.6 according to ISO 898.
c) Material quality of non-structural step bolts shall be Grade 6.9 according to ISO 898.
d) Material quality of nuts shall be Grade 5 according to ISO 898 and appropriate to the material quality of bolts.

8.3.3.2. Unless other specified, bolts and nuts shall be ISO Metric Black Hexagon to BS 4190, and shall be threaded ISO metric course pitch to BS 3643: Part 2, tolerance class 7H/8g.

8.3.3.3. Countersunk and other bolts without hexagon heads shall have slotted heads.

8.3.3.4. All flat washers shall comply with the requirements of BS 4320, Form E, Grade 4.6 or 5.6 appropriate to the material quality of bolts. Unless specified to the contrary they shall be 3 mm thick. Pack washers shall have an external diameter of twice the nominal bolt diameter +15 mm, a hole diameter of nominal diameter +2 mm and a thickness as specified on the appropriate fabrication drawing. Single core spring washers shall comply with the requirements of BS 4464, Type B.

8.3.3.5. Split pins shall comply with the requirements of BS 1574 and shall be of austenitic stainless steel capable of complying with the requirements relating to the inter-crystalline corrosion test of BS EN 10083 etc.

8.3.4 Welding

Consumable for use in metal arc welding shall be in accordance with the requirements of BS EN 1011-1 and -2.

8.3.5 Flooring

Open type floor shall be fabricated from either steel complying with BS EN 10025 Grade S275JR or BS EN 515, 573, 755 and 12020. Minimum thickness for load bearing, transverse and pressed bars shall not be less than 3.0 mm.

8.4 Workmanship

8.4.1 General

8.4.1.1 The work shall be carried out in a thoroughly reliable and workmanlike fashion in order to ensure satisfactory assembly and erection, interchangeability of similar members, accuracy of dimensions, position and alignment of holes.

8.4.1.2 Punched holes, shall wherever practicable, be Jig, NC or CNC punched true to form and free from rags, burrs and distortions. Punches and dies shall be strictly monitored to ensure that any producing, irregular holes or defects previously mentioned shall be immediately replaced. Drilled holes shall be clean, free from burrs and square to the surface of the material.

8.4.1.3 Hole diameters shall be in the black unless specified to the contrary. For bolts up to but not including 30 mm diameter - nominal diameter +1.5 mm. For bolts 30 mm diameter or greater - nominal diameter + 2.0 mm.

8.4.2 Cutting

8.4.2.1 Cutting of materials by either cropping, shearing, guillotining will be permitted up to and including the thickness specified below:

Quality (sub-grade)	JR	- 16 mm
	JO	- 20 mm

8.4.2.2 Materials of either greater thickness or higher quality (sub-grade) must be either machine frame-cut or cold sawn. Hand held flame-cutting is not permitted.

8.4.2.3 Where materials are cropped, sheared or Guillotined, the finished edge shall be free form rags, burrs, notches and distortions. Flame-cutting of grade S355 steel shall be preceded by a slight pre- heat by passing the cutting, flame over the area to be cut and the cutting speed reduced in comparison to those normally used for Grade S275 steels of similar thickness. Every effort shall be made to avoid having the flame-cut edge in tension, especially in grade S355. The flame-cut edges shall be lightly dressed after cutting to remove notches etc.

8.4.3 Drilling and Punching

8.4.3.1 Punching, full sized holes will be permitted up to and including the thickness specified below:

Quality (sub-grade)	JR	- 16 mm
	JO	- 20 mm

8.4.3.2 No hole shall be punched where the thickness of the materials exceeds the finished diameter of the hole. Finished holes shall be true to form and free from rags, burrs and distortion.

8.4.3.3 Materials of either greater thickness or higher quality (sub-grade) must be either drilled to final diameter or punched 2 mm undersize and reamed or core drilled to final diameter. Welding up of misplaced holes is not permitted without the prior approval of the Employer. **This is a Hold Point.**

8.4.3.4 In the case where approval is granted, the new hole must be drilled where it passes through or adjacent to the weld are of the previous hole irrespective of material grade or thickness.

8.4.4 Presswork/Bending

8.4.4.1. All bends in grades S355JO and S355J2G3 steel over 90 in 1000 shall be made hot within the temperature range of 850 to 1000 °C, but normal cold correction will be permitted.

8.4.4.2. Means shall be provided for the random checking of temperatures (Tempilstiks or Pyrometer).

8.4.4.3. Bends in grades S235JRG2 and 275JR steel plates up to 10 mm thick may be made cold up to an including 1175 in 1000.

Bends, open and close flanges in angle sections may be made cold up to and including 600 in 1000.

8.4.4.4. However, in both of the above cases, the Contractor shall take adequate precautions to avoid the risk of subsequent galvanizing embrittlement.

8.4.4.5. Bends shall be of even, profile and free from surface damage due to press tools indentations.

8.4.4.6. The formation of bends by the 'cut and weld' method unless specified on the drawings, is not permitted without prior approval of the Employer**. This is a Hold Point.**

8.4.5 Welding

8.4.5.1 All welding shall be carried out in accordance with BS EN 1011-1 and -2.

8.4.5.2 Pre-heating, where required, shall be checked by the use of Tempilstiks or similar over an area of 150 mm either side of the weld area.

8.4.5.3 Assembly welds (tacks) shall be carried out to the same procedures and welding conditions as the main welds and shall be at least 50 mm long.

8.4.5.4 Stop-start positions shall be kept to a minimum and shall be kept clear by a minimum of 25 mm of all corners and edges of plates (i.e. the weld must be laid down continuously at these points). Where the first run in multi-run welds is larger than subsequent runs, welding should continue until completed, thereby ensuring the weld area is not allowed to cool. After completion the unit should be allowed to cool slowly and should not be subjected to draughts or low temperatures.

8.4.5.5 Where materials are to be galvanized, all welds shall be continuous so as to ensure a pickle-tight connection and shall be thoroughly cleaned (preferably by shot-blasting) to remove all slag, manganese (Carbon Dioxide welding), and weld splatter.

8.4.6 Erection Marks

8.4.6.1. Before leaving the fabricator's works, all members shall be stamped with distinguishing numbers and/or letters corresponding to those on the general arrangement or fabrication drawings. Additionally, the agreed fabricator's identification symbol must appear adjacent to the erection mark.

8.4.6.2. Erection marks shall be stamped on before galvanizing, using characters at least 10 mm high and shall be clearly legible after galvanizing.

8.4.6.3. Erection marks shall be located as follows:

a) All members - stamped within 600 mm of the end but clear of holes;
b) Plates or flat bars - stamped at most suitable position between holes;
c) Main leg and elevation diagonal members - stamped at top end of bar;
d) Horizontal members - stamped at either end of bar;
e) Steel poles 100 mm either side of the joint.

8.4.6.4. Where malleable cast iron fittings are used the erection mark shall be 6 mm high raised characters, where appropriate the following information shall be included :

a) specified minimum failing load;
b) date of manufacture (month and year)
c) cast code.

8.4.6.5. The erection marks shall be: AAAA-BBB-C

8.4.6.6. Where, AAAA - Tower Type, BBB - Mark Number, and C - Steel Grade (H for high tensile steel and M for mild steel)

8.4.6.7. Erection mark coding shall be agreed with the Employer. **This is a Hold Point.**

8.5 Protective Treatment

8.5.1 Galvanizing

8.5.1.1. Unless otherwise specified after completion of all fabrication processes (including all drilling, punching, stamping, cutting bending and welding) support steelwork, poles and pole steelwork, including nuts, bolts and washers shall be hot-dip galvanized and tested in accordance with the requirements of BS EN ISO 1461. Electro-galvanizing is not an acceptable alternative.

8.5.1.2. The minimum average coating thickness shall be as follows:

	Thickness µm	(Mass g/m²)
Steel articles which are not centrifuged, 6 mm thick and over	85	(610)
Steel articles which are not centrifuged, under 6 mm but not less than 3 mm	70	(505)
Grey and malleable iron castings	85	(610)
Threaded works and other articles which are centrifuged	50	(360)

8.5.1.3. Excessively thick or brittle coatings due to high levels of silicon or phosphorus in the steel, which may result in an increased risk of coating damage and/or other features that make the final product non-fit-for-purpose shall be cause for rejection.

8.5.1.4. The ingot zinc used for galvanizing shall comply with the requirements of BS EN 1179.

8.5.1.5. All materials prior to galvanizing shall be free from oil, grease or any substance which may adversely affect the quality of finish.

8.5.1.6. Castings should be as free as possible from surface porosity and shrinkage holes and should be cleaned by grit blasting, electrolytic pickling or by other means specially suitable for castings.

8.5.1.7. The preparation for galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated materials.

8.5.1.8. Unless otherwise specified, all materials shall be treated with Sodium Dichromate in order to prevent wet storage stains (white rust) during storage and transport.

8.5.1.9. All bolts and screwed rods, including the threaded portions, shall be galvanized. The threads shall be cleaned of all surpluses on packing, clear of the ground and away from all materials that might stain or corrode the galvanizing. Black steel packing or bins shall not be spelter by spinning or brushing. Dies shall not be used for cleaning threads other than on nuts. Nuts shall be galvanized and tapped 0.4 mm oversize and threads shall be oiled.

8.5.1.10. Bolts shall be delivered with nuts run up the full extent of the thread. All galvanized materials shall be stored used.

8.6 Tower Erection

8.6.1 General

The Contractor shall provide the Employer with a method statement giving sequential details of the erection method and including his intended program. The method statement shall be submitted to the Employer for acceptance the requisite period before support erection commences. **This is a Hold Point.**

8.6.2 Safety

The erection shall be carried out in accordance with guidance given in the relevant parts of BS 5531 and current health and safety legislation.

8.6.3 Site Storage

All support steelwork stored at site shall be kept clear of the ground where possible. Contact with brackish water, or other substances likely to attack galvanizing shall be avoided and all tower members kept in a clean and tidy condition.

Preventative measures shall be taken to prevent deterioration of galvanized or other protective surfaces during transport, storage and erection. Superficial rust stains shall be removed without causing damage to the protective surfaces.

8.6.4 Damaged Steelwork

Unless otherwise directed, steelwork damaged during off-loading, transportation, storage or erection shall be replaced.

8.6.5 Damaged Galvanizing

The renovation of damaged area of galvanizing shall be carried out using a technical agreed with the Employer. **This is a Hold Point.**

8.6.6 Workmanship

8.6.6.1 The Contractor shall ensure that Towers are not strained or damaged in any way during erection. As far as practical, bolt heads, rather than nuts, shall be on the inner or downward faces of support joints. Bolt locking, after erection shall be in accordance with the requirements of **Annex 8-10**.

8.6.6.2 All holes that align through both components of double angle (back to back) members shall be filled by fitting, a bolt, with suitable pack washers between components. All spare holes (e.g. holes

for alternative positions of supplementary fittings) in double angle members shall be included in this requirement.

8.6.6.3 Towers shall be erected vertically within a tolerance of 0.1 percent of the overall height before conductor erection.

8.6.7 Anti-Climbing Devices, Danger and Identification Plates

As soon as practical after completion of support erection, anti-climbing devices, danger and identification plates in accordance with the requirements of the Sub-clause 8.2.13.

All ladders and temporary step bolts below the anti-climbing device shall be removed when erection work is not in progress.

8.6.8 Aircraft Navigation (Obstruction Aids)

8.6.8.1 Where required aircraft navigation obstruction lights complete with all necessary cabling, control equipment, solar panels, storage batteries, access ladders and platforms shall be fitted.

8.6.8.2 All installation shall be in accordance with approved general arrangement drawings and supplier's instructions.

8.6.8.3 Reference shall be made to Section 15- Aircraft Navigation (Obstruction Aids) for details of the specific requirements.

8.7 Quality Control

8.7.1 General

8.7.1.1. Routine tests on raw material and fabricated individual members (components) of lattice steel towers and associated steelwork shall be undertaken in accordance with the requirements of this specification. Prototype (type) tests on lattice steel towers shall be undertaken when required by the Employer in accordance with the requirements of Clause 8.7.7.

8.7.1.2. All steel ex-mills or received from merchants' stocks shall be marked to identify the cast or casts from which it was made in accordance with Section 9 of BS EN 10025 and Section 10 of BS EN 10210, and be covered by a test (mill) certificate stating the mechanical, chemical and where specified the impact properties and carbon equivalent value and clearly showing the cast numbers; to prove compliance with tables 2 and 5 of BS EN 10025 and tables A1 and A3 of BS EN 10210.

8.7.1.3. The optional impact test BS EN 10210 option 1.6 for quality JO steel hollow sections is required.

8.7.1.4. Unless agreed to the contrary the following maximum Carbon Equivalent Values (CEV) for steel supplied in accordance with BS EN 10025 and BS EN 10210 shall not be exceeded (see also BS 5950 Part 2, Clause 4.2):

Grade	S235	0.35

Grade	S275	0.41
Grade	S355	0.45

8.7.1.5. All high tensile steel solid round sections shall be ultrasonic tested for laminations at the rolling mills in accordance with the requirements of BS EN 10160.

8.7.1.6. In the event of test certificates being unobtainable, the Contractor shall arrange, at his own cost, for the independent testing and analysis of materials. Testing shall be in accordance with the requirements of BS EN 10025, Section 8 and BS EN 10210, Section 7.

8.7.1.7. The material grades of all individual pieces shall be capable of positive identification at all stages of fabrication.

8.7.1.8. Steels of different quality shall be stored separately.

8.7.1.9. Bolts and nuts shall be covered by the appropriate test certificate in respect of the tests requirements stated in BS 4190.

8.7.1.10. Copies of all test certificates shall be made available to the Employer.

8.7.1.11. Three nos. locknuts (anti-theft type) as proposed by the Contractor shall be demonstrated up to ultimate capacity at each of the following stages for acceptance: (i) Factory Acceptance Test (ii) Post Landing Inspection and (iii) During Tower Erection. Failure to comply the requirement in any of the above stage will lead to rejection of such material. The Contractor shall bear all the costs of replacement to fulfil the specification of the Contract document.

8.7.1.12. For bolts, nuts and washers of predesigned tower, dimensional tolerances shall be as per the standard mentioned in clause 8.3.3 instead of the reference standard mentioned in the drawings of the existing predesigned towers. The contractor has to submit the relevant drawing of nuts, bolts, ACD, step bolts complying the standard mentioned in clause no. 8.3.3 for approval.

8.7.2 Welding

8.7.2.1. Unless specified to the contrary all structural welded joints shall be undertaken using approved welding procedures in accordance with BS EN 288.

8.7.2.2. Copies of the welding procedures shall be made available to the Employer upon request. However, for all welding associated with the fabrication of high tensile steel solid round sections, or where the combined thickness of the material is in excess of 60 mm, the welding procedures shall be submitted to the Employer for approval, together with the related quality control documentation such as electrode storage, drying and handling requirements. **This is a Hold Point.**

8.7.2.3. All welders shall be tested to meet the requirements of BS EN 287 Part 1 using the appropriate test corresponding to the weld positions and parent materials to be used. Copies of the test certificates shall be made available to the Employer upon request.

8.7.2.4. The Employer reserves the right to have any welding operator retested at any time at no extra cost.

8.7.2.5. Unless specified to the contrary all welding shall be subjected to a non-destructive testing (NDT) programme. Where necessary, this may involve the appointment by the supplier of an

independent NDT organization approved by the Employer who will undertake the NDT programme. **This is a Hold Point.**

8.7.2.6. The NDT organization shall have operators suitably qualified to Level 2 of PCN / WSB / MT / 001 / 87. The NDT organization shall submit their proposed procedures for approval. **This is a Hold Point.**

8.7.2.7. The Contractor shall then ensure that the approved procedures are rigidly adhered to.

8.7.2.8. The Contractor shall arrange for the appropriate level of weld/inspection to be undertaken, which shall not be less than the following minimum requirements. For details of the required level of inspection reference should be made to **Annex 8-11**.

Level 1: 100 percent visual inspections in accordance with the requirements of BS EN 970
Level 2: 10 percent of the overall output shall be magnetic particle tested to the acceptance criteria stated in BS EN 1011-1 and 2 for butt and fillet welds respectively.
Level 3: 10 percent of each welder's output shall be magnetic particle tested to the acceptance criteria stated in BS EN 1011-1 and -2 for butt and fillet welds respectively.
Level 4: 20 percent of each welder's output shall be magnetic particle tested to the acceptance criteria stated in BS EN 1011-1 and -2 for fillet welds.
Level 5: 10 percent of each welder's output shall be ultrasonic tested, with a further 10 percent of each welder's output magnetic particle tested - both to the acceptance criteria in BS EN 1011-1 and 2 for butt welds.

Notes:
A All welds, especially butt welds must be continuous to ensure a pickle-tight connection when galvanized.
B Ultrasonic testing to be in accordance with BS EN 1714.
C Magnetic particle testing to be in accordance with BS EN ISO 9934.

8.7.2.9. All weld inspection/testing, shall be undertaken a minimum of 48 hours after the completion of the respective weld**. This is a Notification Point.**

8.7.2.10. Copies of the NDT inspection reports for weld inspection levels 5 and 4 shall be made available to the Employer.

8.7.2.11. Copies for the NDT inspection reports for weld inspection level 3 and 2 shall be made available to the Employer upon request.

8.7.3 Castings

All malleable cast iron castings shall be thoroughly inspected after sand blasting, and any casting with castings defects e.g. sand inclusions and metal penetrations, cracking, raised core, porosity shall be scrapped.

8.7.4 Check Erection

8.7.4.1. Prototype structures (and, where required by the Employer repeat structures) shall be check erected in order to verify the accuracy of detailing and fabrications, including forming, location and size of bolt holes, clipping and shearing.

8.7.4.2. The degree of check erection shall be sufficient to verify not only the main structure, but all ancillary steelwork such as platforms, walkways, ladders etc.

8.7.4.3. In the case of lattice towers, the minimum check erection required shall be one face lying horizontally and the adjacent face erected in the vertical plane, complete with hip and plan bracings. Crossarms and earthwire peaks shall be completely assembled.

8.7.4.4. Sufficient blocking and support shall be provided to prevent distortion and overstressing of the members to ensure proper fit. Assembly shall be accomplished without extraordinary effort to align bolt holes or to force pieces into position. Bolt holes shall not be reamed or enlarged.

8.7.4.5. All modifications found necessary at the time of check erection shall be accurately recorded and the Contractor's drawings, NC tapes etc., shall be amended. Where necessary, modified G.A. drawings shall be forwarded to the Employer.

8.7.4.6. Unless otherwise specified the check erection may be undertaken in either the black or galvanized condition. Where materials are check erected galvanized, all modified items, those subjected to damage or prolonged contact with black steel, shall be re-galvanized at the supplier's cost.

8.7.4.7. The Contractor shall give the Employer the requisite period of notice prior to a check erection being ready for inspection**. This is a Hold Point.**

8.7.5 Galvanizing

Tests for galvanized members and components shall be carried out at the works to ensure compliance with the requirements of BS EN ISO 1461. Details of the test results shall be made available to the Employer upon request.

Certificates relating to the ingot zinc used for galvanizing shall also be made available to the Employer upon request. When requested the fabricator shall, at his own cost, provide a pot melt analysis.

8.7.6 Tolerances

The fabrication tolerances after galvanizing, which are not to be considered cumulative, shall be as follows:

a.	On linear dimensions of nominal sections as per BS 4, BS EN 10210-2, BS EN 10024, BS EN 10029, BS EN 10034 & BS EN 10056-2	
b.	On overall length of member	±1 mm
c.	On centres of holes	±1 mm
d.	On centres of groups of holes	±2 mm
e.	On back-gauges	±1 mm
f.	On corresponding holes in opposite faces of angle or channel sections	±1 mm
g.	On specified hole diameter on the punch side + 0.3 mm (in the black) or where drilled	- 0 mm
h.	Taper on punched holes as measured between the specified hole diameter on the punch side and the hole diameter on the die's side (in the black-) shall not exceed	+1.00mm
i.	On specified bends, open and close flange	± 20/1,000

j.	On the specified included angle (in plan) between welded leg connections or bracing connection plates	± 20/1,000

The permitted tolerance from straightness after galvanising shall not exceed an offset of 1: 1,000, except for hollow sections which shall not exceed 1:600 measured at the worst point. For members greater than 3 m in length, the offset shall be measured over any 3 m length in the member.

8.7.7 Tests-Lattice Steel Tower

(a) Prototype Load Test

8.7.7.1. Load tests on lattice steel towers shall be undertaken in accordance with the requirements of IEC 60652 except the last sentence of Sub-clause 14.1 regarding premature failure of Design tests. If a failure occurs in the final load case, the tower shall be re-tested.

8.7.7.2. Each member of the test tower shall have its yield point identified either from certified mill test reports traceable to the actual steel supplied or from test coupons. Yield point values shall be recorded in the test reports.

8.7.7.3. The type and extension of the structures to be tested shall be in accordance with those specified in **Annex 8-12.** In the event of the testing, facilities not be capable of special testing the structures specified, the testing facilities may be assessed by the Employer and the extension reduced; or the Employer has the right to specify a different test facility for testing maximum height structures at no extra cost to Employer.

8.7.7.4. The structure shall be assembled on rigid foundations. If the Contractor, in carrying out erection of structures on site, proposed to assemble the structures on the ground and subsequently raise them to the vertical position, the test structures shall be so erected in the presence of the Employer. The Contractor shall give the Employer the requisite period of notice prior to the erection of the structure. **This is a Notification Point.** Structures submitted for test, together with bolts and fittings shall be galvanized.

8.7.7.5. The test load cases required to prove compliance of the structure design and order of tests shall be agreed between the Employer and the Contractor. There shall be no restrictions on the number of test load cases to be applied to the structure which may include a test to destruction.

8.7.7.6. Loads shall be applied in a manner approved by the Employer and maintained for one minute for below 100% load and three minutes at 100% and above loads without variation. The test programme together with details of the test rigging and load attachment details shall be submitted to the Employer, **This is a Hold Point.**

8.7.7.7. Should it become necessary to adjust the loading, the one minute period shall recommence after the loading is stabilized and constant. All test loads shall be removed completely before the loads for the next tests are applied, unless previously agreed by the Employer. All test loads corresponding to phase conductor and earthwire loading shall be applied directly to the regular attachment details provided for these loads.

8.7.7.8. Any conspicuous yielding or any failure under any test loading or the use of any incorrect grade of steel shall be considered a defect. If a failure occurs, the Contractor shall correct the defect and repeat the test loading at his own expense.

8.7.7.9. Coupons or test samples shall be cut from members which fail in the destruction tests and from those members judged to be critical from the design calculations, and standard tensile tests shall be performed at the Contractor's expense. The results of these tests together with test report and certificate shall be made available to the Employer.

8.7.7.10. Any structure or part thereof which has been subjected to type testing shall not be used subsequently in the construction of the line and not required to supply such structure or part to Employer. The text “T” shall be added in the mark number of angles and plates of the proto type tested tower. All costs related to these towers shall deem to be included in the type test cost of towers in the Price Schedule.

8.7.7.11. The Contractor shall furnish all test structures, testing facilities, rigging, load cells as may be required and shall perform all work herein specified or implied. All items not specifically mentioned shall be deemed inclusive to testing.

8.7.7.12. The Contractor shall give the Employer the requisite period of notice prior to undertaking the tests.

(b) Proto Assembly

8.7.7.13. Proto assembly tower tests shall be conducted before batch manufacturing of the towers. The type and extension of the structures to be proto assembly tested shall be in accordance with those specified in **Annex 8-12**.

8.7.7.14. After successful proto assembly testing, subject to type test (wherever applicable) the respective towers shall be manufactured as per required quantity for supply and installation. Before shipment of such manufactured towers, randomly selected samples shall be tested for each lot as per relevant IEC/British Standard. Dimension check, galvanization thickness test, tensile tests, elongation measurement, impact test and any other test as per Standard shall be performed in this regard at the Contractor's expense. The results of these tests together with test report and certificate shall be made available to the Engineer.

8.7.7.15. The Contractor shall furnish all test structures, testing facilities and shall perform all work herein specified or implied. All items not specifically mentioned shall be deemed inclusive to testing.

8.7.7.16. The Contractor shall give the Engineer the requisite period of notice prior to undertaking the tests.

8.7.8 Certificate of Conformity

The certificate of conformity shall be supported by the following documentation:

a) material test (mill) certificates;
b) bolt and nut certificates;
c) NDT welding inspection (levels 5 & 4);
d) test reports of any prototype or sample tests undertaken;
e) the results of any ultrasonic testing of solid round sections;
f) the results of any welding NDT inspections (levels 3 & 2);
g) Welder's test certificates;
h) galvanizing thickness records;
i) the ingot zinc certificates;
j) galvanizing pot melt analysis;

8.7.9 Quality Control after Erection

8.7.9.1 The Contractor shall be responsible for checking that the Towers are complete and that all bolts have been correctly tightened before conductor commences. A record of this work shall be kept by the Contractor and made available to the Employer on request.

8.7.9.2 Critical bolts are to be marked after erection with red paint to ensure priority checking during maintenance.

8.7.9.3 Where appropriate, test on the aircraft obstruction lighting shall be undertaken to prove compliance of the system. Records of the tests shall be made available to the Employer upon request.

Annex 8-1: Design Parameters and Conductor System Loading

1. Tower Design Requirement

Sl.	Tower Type	Scope of this Contract include Design	Pre-designed Towers will be used
(i)	400kV Overland	-	-
(ii)	400kV River Crossing	-	-
(iii)	230kV Double Circuit Overland	-	-
(iv)	230kV Double Circuit River Crossing	-	-
(v)	230kV Four Circuit	-	-
(vi)	132kV Four Circuit	-	Yes
(vii)	132kV Double Circuit	-	Yes

2. Design Parameters

2.1 132kV Towers

	132kV Towers
3s gust wind speed (Failure Limit)	As per Annex 2-1
Wind load factor	1.0
Exposure category	C

3. Conductor System Loading

3.6 132kV Overland Portion

Loading Condition	Maximum Allowable Tension[1]
Normal condition (Failure Limit)	50% of Ultimate tensile strength
	50% of Ultimate tensile strength (Earthwire & OPGW)
Normal condition (Damage Limit)	50% of Ultimate tensile strength
Everyday condition	20% of Ultimate tensile strength
[1]The bidder/Contractor shall determine the appropriate conductor tension under different loading condition to maintain the minimum height of phase conductors after creep or after load at the support on standard height, from ground level for the corresponding span criteria. Min. height of bottom conductor attachment level is mentioned in Annex under this Section.	

3.7 132kV Overland and River Crossing Portion– Not applicable

Loading Condition	Maximum Allowable Tension[1]
Normal condition (Failure Limit)	50% of Ultimate tensile strength
	50% of Ultimate tensile strength (Earthwire & OPGW)
Normal condition (Damage Limit)	50% of Ultimate tensile strength
Everyday condition	20% of Ultimate tensile strength
[1]The bidder/Contractor shall determine the appropriate conductor tension under different loading condition to maintain the minimum height of phase conductors after creep or after load at the support on standard height, from ground level for the corresponding span criteria. Min. height of bottom conductor attachment level is mentioned in Annex under this Section.	

Annex 8-2: Classes of Towers

The steel towers requires in this project is as follows:

1. **132kV double circuit** three phase vertical formation lattice steel towers with single ACSR Grosbeak conductor per phase and one OPGW.
2. **132kV four circuit** three phase vertical formation lattice steel towers with single ACSR Grosbeak conductor per phase and two earthwires (both of the earthwires shall be OPGW).

Annex 8-3: Designation & Uses of Towers

Designation	Angle of Deviation / Entry	Description	Type of Insulator Set
132kV double circuit tower for single ACSR Grosbeak or equal dia. ACCC			
1DL	0°	Intermediate	Suspension
1D1	0° - 10°	Angle	Heavy Suspension
1D25	0° – 25°	Angle/Section	Tension
1DT6	25° – 60° 0° – 30°	Angle Terminal	Tension Tension
1D9	60° – 90°	Angle	Tension
132kV four circuit tower for single ACSR Grosbeak or equal dia. ACCC			
1QL	0°	Intermediate	Suspension
1Q15	0° - 15°	Angle	Heavy Suspension
1Q30	0° – 30°	Angle/Section	Tension
1QT6	30° – 60°	Angle	Tension
	0° – 30° (Angle of Entry)	Terminal	Tension

Annex 8-4: Support Outline

Annex 8-4(1) Support Extensions

Tower Type	Type of Extension	Range (m)
132kV double circuit towers for Single Grosbeak		
1DL	Body/leg extension	Std., 1.5, 3.0, 4.5, 6.0, 9.0
1D1	Body/leg extension	Std., 1.5, 3.0, 4.5, 6.0, 9.0, 12.0
1D25	Body/leg extension	Std., 1.5, 3.0, 9.0
1DT6	Body/leg extension	Std., 1.5, 3.0, 4.5, 6.0, 9.0
132kV four circuit towers for Single Grosbeak		
1QL	Body/leg extension	Std., 1.5, 3.0, 4.5, 6.0, 9.0
1Q15	Body/leg extension	Std., 1.5, 3.0, 4.5, 6.0, 9.0, 12.0, 15.0
1Q30	Body/leg extension	Std., 3.0, 4.5, 6.0, 9.0
1QT6	Body/leg extension	Std., 1.5, 3.0, 4.5, 6.0 & 9.0

Note:

(i) Std. means Standard height.

(ii) D25 towers shall be designed to accommodate crossarms and clearance for transposing the line.

(iii) DT6 towers shall be designed to accommodate the loads of slack span coming through auxiliary crossarm.

Annex 8-4(2) Basic Dimension of Supports

According to Tower Drawings listed in Section 22.

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Annex 8-5: Span Criteria

Annex 8-5(1) Overland Portion

1.0 Climatic Loadings and Security Loadings (Intact Conditions)				
1.1 Suspension, Heavy Suspension & Tension Supports				
				132kV
Basic Span (m) – Medium Wind Zone				300
Basic Span (m) – High Wind Zone (i.e. 3s gust wind speed = 80m/s)				210
(a1)	Wind span (Medium Wind Zone)	Suspension Towers	(m)	330
		Heavy Suspension Towers	(m)	525
		Tension Towers	(m)	330
(a2)	Wind span (High Wind Zone)	Suspension Towers	(m)	220
		Heavy Suspension Towers	(m)	345
		Tension Towers	(m)	220
(b)	Maximum weight span	Suspension Towers	(m)	525
		Heavy Suspension Towers	(m)	525
		Tension Towers	(m)	525
(c)	Minimum weight span	Suspension Towers	(m)	140
		Heavy Suspension Towers	(m)	140
		Tension Towers	(m)	0
1.2 Terminal Supports				
(a1)	Wind span (Medium Wind Zone)	Terminal Tower	(m)	250
(a2)	Wind span (High Wind Zone)	Terminal Tower	(m)	165
(b)	Maximum weight span	Terminal Tower	(m)	395
(c)	Minimum weight span	Terminal Tower	(m)	0
2.0 Security Loadings (Broken Wire Conditions)				
2.1 Suspension & Tension Supports				
(a1)	Wind span (Medium Wind Zone)	Suspension Towers	(m)	250
		Heavy Suspension Towers	(m)	250
		Tension Towers	(m)	250
(a2)	Wind span (High Wind Zone)	Suspension Towers	(m)	165
		Heavy Suspension Towers	(m)	165
		Tension Towers	(m)	165
(b)	Maximum weight span	Suspension Towers	(m)	395
		Heavy Suspension Towers	(m)	395
		Tension Towers	(m)	395
(c)	Minimum weight span	Suspension Towers	(m)	100
		Heavy Suspension Towers	(m)	100
		Tension Towers	(m)	0

Annex 8-5(2) River Crossing Portion (Anchor to Anchor) – Not applicable

Annex 8-6: System Loading for Non-Pointed Crossarm Connections and Slack Spans Loads

(i) Assumed System Loading Criteria

For non-pointed crossarm loads to be distributed as follows: (for all types of Supports)

	Transverse	Longitudinal	Vertical
Angle/tension towers			
• Normal	50% - 50%	100% - 0%	50% - 50%
• Security			
– intact	50% - 50%		50%-50%
– broken	75% - 25%	100% - 0%	75% - 25%
Terminal/Anchor towers			
• All classes	100% - 0%	100% - 0%	100% - 0%

Wind directions are as shown in the sketch:

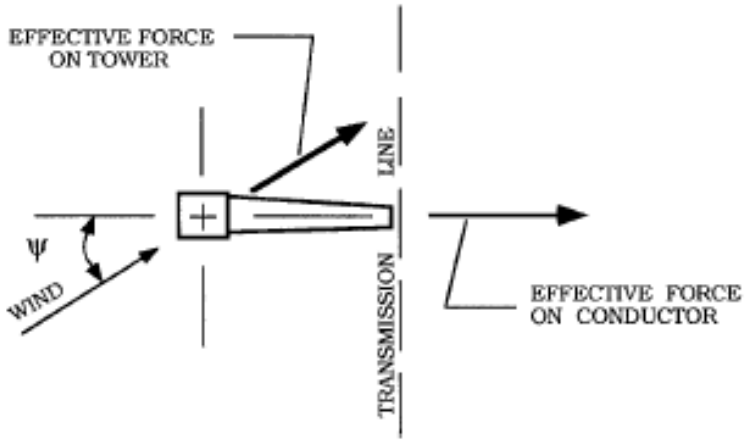


Illustration of yawed wind on a transmission line.

(ii) Slack Span and Downlead Tensions

		132kV	230kV	400kV
(a)	Maximum phase conductor slack span and downlead tension (per sub-conductor)	7.0 kN	10.0 kN	10.0 kN
(b)	Maximum earthwire slack span and downlead tension	4.5 kN	4.5 kN	4.5 kN
(c)	Maximum slack span	100m	100m	100m

Annex 8-7: Minimum Thickness & Diameter of Material

The minimum thickness and diameter of material used in members and bolts shall be as detailed below:

(a)	For leg members and compression chords in gantries and crossarms.	(mm)	6
(b)	For other members (including earthwire peaks) carrying calculated stress.	(mm)	5
(c)	For secondary members without calculated stress.	(mm)	4
(d)	Gusset plates for lattice towers.	(mm)	6
(e)	Bolt diameter for members carrying calculated stress.	(mm)	16, 24 & 30
(f)	Minimum bolt diameter for secondary members without calculated stress	(mm)	16

Annex 8-8: Material Strength Factor

Sl.	Tower Test Provision	Material Strength Factor
(a)	Proto Load tested tower	1.0
(b)	Without proto Load test tower	0.9
(c)	Extension part of the tower that are not tested during Proto Load Test	0.9

Annex 8-9: Electrical Clearances - Live Metal & Earthed Steelwork, Spatial Distances and Downlead Clearances

Annex 8-9(1) Electrical Clearances - Live Metal & Earthed Steelwork

Please also refer to the Bid Drawings, Section 22, Volume 2 of 3 of the bidding documents.

	Description	Unit	132kV
(a)	Minimum clearance between live metal and earthed steel work for suspension sets, and/or conductor, and/or weighted jumper loops and/or pilot suspension sets deflected between 0deg and 10deg from the vertical with the conductor leaving the suspension clamp at any angle between 0° and+10° (downwards) and/or for tension insulators inclined between -5° and +10°. **(Swing under nil wind)**	(mm)	1450
(b)	Minimum clearance between live metal and earthed steelwork for suspension sets, and/or conductor, and/or weighted jumper loops and/or pilot suspension sets deflected between 10deg and 45deg (10deg and 15deg for weighted jumper loops & pilot suspension sets) from the vertical, with the conductor leaving the suspension clamp at any angle between 0° and +10° and/or tension insulators inclined between -5° and +10°. **(Lightning Impulse Clearance)**	(mm)	900
(c)	Minimum clearance between live metal and earthed steelwork for unweighted jumper loops deflected between 10° and 25° from the vertical. **(Lightning impulse clearance)**	(mm)	900
(d)	Minimum clearance between live metal and earthed steelwork for suspension sets, and/or conductor, and/or weighted jumper loops and/or pilot suspension sets deflected between 45^0 and 70^0 from the vertical, with the conductor leaving the suspension clamp at any angle between 0° and +10°. **(Power frequency clearance)**	(mm)	500

Note: In case of new tower design, the actual maximum angle deflection of suspension sets, and/or conductor, and/or weighted jumper loops and/or pilot suspension sets shall be calculated with the wind load.

Annex 8.9(3) Spatial Distances

			132kV
(a)	Minimum shielding angle of the earthwire (still air) from the vertical	(degrees)	30°
(b)	Maximum swing of the earthwire from vertical	(degrees)	85°
(c)	Minimum vertical spacing between adjacent phases	(m)	4.0
(d)	Minimum projected horizontally spacing between adjacent phases spaced vertically	(m)	-
(e)	Minimum vertical spacing between phase conductor and earthwire	(m)	3.2
(f)	Minimum horizontal spacing between adjacent phase conductors spaced horizontally.	(m)	-

Annex 8.9(4) Downlead Clearances

			132kV
(a)	The minimum clearance in still air at the assumed maximum conductor temperature between adjacent downleads shall not be less than.	(m)	2.7
(b)	In exceptional circumstances and with the approval of the Employer, based on the condition of maximum (opposing) conductor swing and sag, the clearance may be reduced to.	(m)	-

Annex 8-10: Anti-Climbing Devices (ACD), Access Facilities, Danger & Identification Plates

Annex 8.10(1) Anti-Climbing Devices (ACD)

			Required/Not Required
(a)	Barbed wire type at a minimum height above ground level	(m)	Not required
(b)	Spiked type at a minimum height above ground level	(m)	3.0
(c)	Bolt Locking		All bolts below the bottom crossarm level shall be locked by locknuts (anti-theft type).

Note: The contractor is required to propose the type of locknuts (anti-theft type) for necessary approval from the employer during execution stage and submit corresponding standards related to the proposed lock nuts. For pre-designed towers, bolt length may require to be revised. All costs related to bolt length revision and subsequent change in supply price, is deemed to be included in contract price.

Annex 8.10(2) Access Facilities

(a)	Step bolts	Fitted between Ground level & within 1m of top of towers
(b)	Ladders	Ladders are fitted all through between the ACD and Peak for river crossing suspension towers. For Predesigned towers existing drawing shall be followed.
(c)	Rest platforms	For river crossing suspension towers. As per BS 4211. For Predesigned towers existing drawing shall be followed.
(d)	Work platforms	Required for tension towers & river crossing towers at every Crossarm level. For Predesigned towers existing drawing shall be followed.
(e)	Fall arrest system	Every Crossarm

Annex 8.10(3) Danger &Identification Plates

(a)	Danger plate	Required
(b)	Tower number, circuit identification & phase colour plate	Required

Annex 8-11: Quality Control Weld Inspection Levels

Level 1: All welded items not covered by higher level of inspection

Level 2:

Level 3: Conductor attachment fittings for all types of towers.

Annex 8-12: Tower Test Requirements

Annex 8-12(1): Type Test Requirement - Not applicable

Annex 8-12(2): Proto Assembly Test Requirement

All towers with all extensions shall require proto assembly tests to be performed in the manufacturer's/test station's premises before starting the batch manufacturing of towers.

The shop drawings are required to be submitted in hardcopy and soft copy (AutoCAD) before proto assembly test. **This is a Hold Point.** After the successful proto assembly test, the shop drawings shall deem to be approved. The Contractor shall, then, provide the Employer complete sets of final soft copy (Auto CAD) and hardcopies of the drawings for reference purpose. The overall responsibility of fabricating tower members correctly lies with the Contractor only and the Contractor shall ensure that all the tower members can be assembled/ fitted while erecting without any undue strain on them.

All costs related to such tests shall deem to be included in the Contract Price.

Annex 8-12(3): Visual Check, Galvanizing Test and Mechanical Test of Members /Nuts & Bolts /Plates

Before mass (batch) fabrication/manufacturing of tower materials the Contractor shall submit the proto assembly test report of towers for acceptance of the Employer. The Contractor shall proceed mass fabrication of towers after acceptance of the said test report by the Employer. After mass fabrication, tower members shall visually check for dimension and galvanizing thickness (which shall include weight basis test also). Mechanical tests shall also be done on the finished tower materials.

All costs related to such tests shall be deemed included in the Contract Price.

Annex 8-13: Foundation Reaction Forces

Annex 8.13(1): 132kV Double Circuit Towers (Narrow Base Width)

(Including Foundation Overload Factor 1.23)

Tower Type	Down Thrust (Along the Leg)	Uplift (Along the Leg)	Horizontal Component	
			Hx (Transverse)	Hz (Longitudinal)
	Kg	kg	kg	kg
1DL	115226	107703	772	772
1D1	190459	177936	3339	3339
1D25	264413	212986	5839	5839
1DT6 (Angle)	340720	258860	5853	5853
1DT6 (Terminal)	375471	433954	6537	6537

Annex 8.13(2) 132kV Four Circuit Towers

(Including Foundation Overload Factor as 1.23 for 1QL and 1.35 for others)

Tower Type	Down Thrust (Along the Leg)	Uplift (Along the Leg)	Horizontal Component	
			Hx (Transverse)	Hz (Longitudinal)
	Kg	kg	kg	kg
1QL	127705	111399	4118	2449
1Q15	255355	229080	5531	4066
1Q30	306244	279876	6808	5344
1QT6 (Angle)	411063	364820	8929	7790
1QT6 (Terminal)	502180	459627	10039	8044

Annex 8.13(3) 230kV Double Circuit Towers– Not applicable

Annex 8.13(4) 230kV Four Circuit Towers– Not applicable

Annex 8.13(5): 4000kV Double Circuit Towers -– Not applicable

Note: Strength Factor Shall be as per Chapter 7.

Annex 8-14: Engineering Documents to be Submitted by Contractor

Clause Reference	Document Description	Comment
8.2.21	Design calculation	
8.2.22	Fabrication drawings	
8.6.1	Method statement - tower erection	
8.7.1	Material test certificates	
8.7.1	Bolt & nut test certificates	
8.7.2	Welding procedures	
8.7.2	Welder's test certificates	
8.7.2	NDT procedures	
8.7.2	NDT inspection reports	
8.7.5	Galvanising test records	If requested
8.7.5	Ingot zinc certificates	
8.7.5	Pot melt analysis	
8.7.7	Proto type tower test programme	
8.7.7	Proto type test reports	
8.7.8	Certificate of conformity	
8.7.9	Tower erection records	

Annex 8-15: Notification and Hold Points

Clause Reference	Notification Points	Hold Points
8.2.21		Design calculation
8.2.22		Fabrication drawings
8.4.3		Misplaces holes
8.4.4		Formation of bends
8.4.6		Erection marks
8.6.1		Method statement
8.6.5		Damaged galvanizing
8.7.2	Welding inspection/testing	Welding procedure
8.7.2		NDT organisation
8.7.2		NDT procedure
8.7.4		Proto type tower erection
8.7.7	Proto type tower test	Proto type tower test programme

Annex 8-16: Reference Standards

Thereferencestandardsandotherdocumentsreferredtointhisspecificationarelistedbelow:

IEC 60652:	Loading Tests on Overhead Line Towers
BS 4:	Structural Steel Sections, Part 1: Specification for hot rolled sections
BS 183:	Specification for general purpose galvanized steel wire strand
BS EN 10244-2:	Specification for testing zinc coatings on steel wire and for quality requirements.
BS EN 134411-1:	Specification for thimbles for wire ropes.
BS EN ISO 1461:	Specification for hot-dipped galvanizing coating, on iron and steel article.
BS 970:	Specification for wrought steel for mechanical and allied engineering purposes. General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steel
BS EN 10083, 4, 5, 7, 8; BS EN 10095, BS EN 10250-4; BS PD 970; BS EN 515:	Specification for wrought aluminium and aluminium alloys for general engineering purposes bars, extruded round tubes and sections.
BS EN 573-3, 4; BS EN 755-1 to 9; BS EN 12020-1,2; BS 1574:	Specification for split cotter pins.
BS EN 1563:	Specification for spheroidal graphite or nodular graphite cast iron.
BS 3643:	ISO Metric screw threads. Part 2: Specification for selected limits of size
BS EN 1714:	Method of ultrasonic examination of welds. Method of manual examination of fusion welds in ferric steel.
BS 4102:	Steel wire and wire products for fences.
BS 4190:	Specification for ISO metric hexagon bolts, screws and nuts.
BS 4211:	Ladders for permanent access to chimneys, other high structures, silos and bins.
BS 4320:	Specification for metal washer for general engineering purposes. Metric series.
BS 4464:	Specification for spring, washers for general engineering and automobile.
BS 4592:	Industrial type metal flooring, walkways and stair treads. BS EN ISO 14122-1 to 3
BS EN 10210-2:	Hot rolled structural steel sections. Specification for hot-finished hollow sections.
BS EN 10056-1:	Equal and unequal angles.
BS EN 1011-1,2:	Specification for arc welding of carbon and carbon manganese steels
BS EN 970:	Code of practice. Visual inspection of fusion welded joints.
BS 5531:	Code of practice. For safety in erecting structural frames.

BS 5950:	Structural use of steelwork in buildings.
BS ISO 10160:	Methods of ultrasonic testing and specifying, quality grades of ferric steel plates.
BS EN ISO 9934:	Methods for magnetic particle flow detection.
BS EN 1562:	Specification for malleable cast iron.
BS EN 287:	Approval testing of welders for fusion welding.
BS EN ISO 15607:	Specification and approval of welding procedures for metallic materials.
BS EN ISO 15609; BS EN ISO 15610, 15611, 15612, 15613, 1561; BS EN 353:	Personal protective equipment against falls from heights
BS EN 353-1:	Guided type fall arresters including a rigid anchorage line.
BS EN 353-2:	Guided type fall arresters including a flexible anchorage line.
BS EN 360:	Personal protective equipment against falls from a height. Retractable type fall arrestors.
BS EN 1179:	Specification for Zinc & Zinc Alloys - Primary zinc.
BS EN 10024:	Hot rolled taper flange I-sections. Tolerance on shape and dimensions.
BS EN 10025:	Specification for hot rolled products of non-alloyed structural steels and their technical delivery requirements.
BS EN 10029:	Tolerance on dimensions, shape and mass of hot rolled steel plate 3 mm thick or above.
BS EN 10034:	Structural steel I and H sections. Tolerance on shape and dimensions.
BS EN 10056:	Specification for structural steel equal and unequal angles; Part 2: Tolerance on shape and dimension
BS EN 10163:	Delivery requirements for surface conditions of hot rolled steel plates, wide flats and sections. Part 1: General requirements; Part 2: Plates and wide flats; Part 3: Sections
BS EN 10210-1:	Hot finished structural hollow sections of non-alloy and fine grained structural steels- Technical delivery requirements
BS 8100-3	Code of Practice for strength assessment of members of lattice towers masts.
ANSI/ASCE Std 10-15	Design of Steel Transmission Towers.
BS EN 50341-1:2012:	Overhead electric lines exceeding AC 1 kV - Part 1: General requirements - Common specifications

ASCE Manual and reports on Engineering Practice no. 74. Guideline for Electrical Transmission Line, Structural Loading Third Edition.

9. Insulators

9.1 Scope

Both, the type of insulator unit and insulator set, whether suspension or tension used on each type of support, shall be approved, and shall have proven use under similar environmental and operational conditions.

Insulator strings shall comprise of porcelain disc insulator units. All types of insulators to be supplied under this Contract shall be supplied from the same manufacturer.

Please refer to **Annex 9-1** for details of the specific requirements.

9.2 Design

9.2.1 General

All insulator units shall be designed to withstand the design service voltages including lightning, switching and power frequency, the mechanical loads relevant to the installation-service- maintenance conditions, the service temperature and environmental effects. Internal stresses due to expansion and contraction of any part of the insulator unit shall not lead to deterioration.

The design of insulator units shall be such as to avoid local corona formation and no significant radio interferences shall be exhibited. Cap &pin insulator units shall comply with the general requirements of the IEC 60305 standard, except where specified otherwise in this Specification and insulator units shall have straight head design to avoid concentration of mechanical stress. Cross section sketch of insulators unit showing the head design is included in the enclosed Drawing Section of this specification.

9.2.2 Electrical and Mechanical Characteristics

The individual insulator units shall be complete insulator sets shall have the electrical and mechanical characteristics stated in **Annex 9-2**

9.2.3 Couplings

Couplings between individual insulator units shall be as specified in **Annex 9-1.** Ball and socket couplings shall be in accordance with the requirements of IEC 60120. Sockets shall either have W type security clips, or a split pin (R) clip in accordance with the requirements of IEC 60372 as specified.

9.2.4 Pollution

The design of insulator units shall take into account the principles contained in IEC 60815 for the specified pollution category. However, minimum creepage values (mm/kV) shall be as specified.

9.2.5 Zinc Sleeve

Cap and pin insulator units shall where specified be fitted with zinc sleeve pins to prevent cracking due to pin corrosion caused by the effects of pollution and high humidity. The exposed part of the sleeve shall have a mass of at least 5 (five) gram and metallurgic alloy bonded to the insulator pin.

9.2.6 Insulator Protective Device

The design of insulator protective fittings including corona shields shall comply with the following requirements:

a) Shall effectively protect the insulator units, and the fittings from damage caused by power arcs;
b) Shall effectively improve the voltage distribution along the insulator string;
c) Shall effectively improve the corona performance of the insulator set;
d) Shall be designed in such a way as not to be subject to breakage fatigue due to wind induced vibration;
e) Shall withstand a specified mechanical load.
f) Shall be suitable where specified for live-line maintenance.

For details of the materials, workmanship and quality control requirements for insulator protective fittings reference shall be made to Section 10 of this specification.

9.2.7 Low Duty Insulator Sets

Low duty tension sets shall be used for the downleads between terminal supports and substation gantry structures or other positions where the conductor tensions are of a reduced value. At the lower end of the downleads the low duty tension sets shall be capable of having their units reversed.

9.2.8 Tension Insulator Sets-Earth End Linkages

Additional earth end adjustable linkages shall be provided where necessary to ensure that either the specified clearance is maintained between the tension insulator set and the support body/crossarm, or that satisfactory pairing is achieved between the phase sub-conductors.

9.3 Materials

9.3.1.1. High grade, wet process porcelain used in the manufacturer of insulator units shall comply with the requirement of IEC 60672.

9.3.1.2. Insulator caps and bases of malleable cast iron shall be manufactured from a suitable grade of MCI complying with the requirement of BS EN 1563 for spheroidal graphite, or BS EN 1562 for white heart and pearlytic. Ductile cast iron of suitable grade may be used for caps and bases.

9.3.1.3. Insulator end fittings of forced or cast aluminium alloy shall be manufactured from a suitable grade of aluminium alloy complying with the requirements of BS EN 515, 573, 586, 603, 604 or BS EN 1559, 1676, 1706 and/or BS EN 1676 or equivalent respectively.

9.3.1.4. Security 'W' clips shall be of phosphor-bronze composition in accordance with the requirements of BS EN 1172, 1652, 1653, 1654 or equivalent and supplied in the half-hard condition with a minimum harness of 155 VPN.

9.3.1.5. Security 'R' clips shall be of austenitic stainless steel capable of complying with the requirements of relating to inter-crystalline corrosion tests of BS 970: Part 1 and BS EN 10084, 10085, 10087, 10095, 10250 and PD 970.

9.3.1.6. Zinc sleeve shall have a total impurity not greater than 0.2 percent and shall comply with the requirement of BS EN 1179 or equivalent.

9.4 Workmanship

9.4.1 Insulator Units

9.4.1.1. The dimensions of all insulator units, together with materials and grades and other pertinent information shall be shown on the contract drawings. Contract drawings shall be submitted to the Engineer. **This is a Hold Point.**

9.4.1.2. Particular regard shall be paid to those dimensions which involve interchangeability, correct assembly and those for which gauges are specified. Where appropriate insulator caps and pins shall comply with the requirement of IEC 60120, IEC 60372 and IEC 60471.

9.4.1.3. Porcelain shall be sound, thoroughly vitrified and free from defects and blemishes which might adversely affect the life of the insulator units.

9.4.1.4. Cement used in the construction of an insulator unit shall not fracture by virtue of expansion, nor loosen by contraction and proper care shall be taken to locate the individual parts correctly during assembly. The cement shall not give rise to chemical reaction with metal fittings nor the zinc collars. The cement thickness shall be as uniform as possible.

9.4.1.5. All insulator caps and bases are to be free from flaws, blowholes and shall be of a close-grained quality.

9.4.1.6. Insulator pins shall be round, free from cracks, surface flaws, lamination and other defects.

9.4.1.7. The zinc sleeve shall not be porous and all mould lines shall be removed. The cement level shall be approximately at the mid-point of the sleeve.

9.4.2 Identification and Marking

All insulator units shall be marked to ensure a system of traceability. Each unit shall be clearly and indelibly marked as follows on the insulating component according to the requirements of IEC 60383-1:

a) Electromechanical failing load;
b) Name or trade mark of the manufacturer;
c) Year of manufacture.

9.4.3 Installation Criteria

The manufacturer shall where necessary provide comprehensive instructions in a suitable format regarding, the handling and installation of insulator units.

9.4.4 Erection

9.4.4.1. The Contractor shall provide the Engineer with a method statement giving sequential details of the proposed erection method. The method statement shall be submitted to the Employer, the requisite period before insulator set erection commences. **This is a Hold Point.**

9.4.4.2. Care shall be exercised in the handling and erection of insulator units to prevent scratches, chipping or cracking of the insulation medium.

9.4.4.3. The Engineer shall be reasonable entitled to request the removal and destruction of any insulator units from a string which they notice has been severely handled or knocked during erection. All units which are scratched, chipped or abraded shall be removed and replaced. Insulator units and fittings shall be laid on plastic sheets prior to erection and any foreign matter shall be removed prior to installation.

9.4.4.4. The Contractor shall ensure that insulator units are not strained or damaged in any way during, erection.

9.4.4.5. All bolt threads shall be coated with an approved grease immediately before erection.

9.5 Protective Treatment

9.5.1 All insulator caps, bases and pins shall either be inherently resistant to atmospheric corrosion or suitably protected against corrosion, such as may occur in transit, storage and in service. All ferrous parts which will be exposed to the atmosphere in service, except those made in the appropriate grade of stainless steel, shall be protected by hot dipped galvanizing to comply with the requirements of BS ISO 1461. All manufacturing processes shall be completed prior to galvanizing.

9.5.2 The ingot zinc used for galvanizing shall comply with the requirements of BS EN 1179 or equivalent.

9.5.3 All galvanized materials shall be stored on packing, clear off the ground and away from all materials that might stain or corrode the galvanizing. Black steel packing, or bins shall not be used.

9.6 Quality Control

9.6.1 General

9.6.1.1 Type, sample and routine tests shall be undertaken on all insulator units and type tests on insulator sets in accordance with the requirements of this specification.

Details of the test requirements are summarized in **Table9.1**.

Acceptance criteria for thermal mechanical performance test and electromechanical failing (EMT) load test shall be governed by the following, formula, irrespective of sample size:

$$3 \leq C = (X\text{-}SFL) / \sigma$$

where,
C = Acceptance constant
X = Mean value of failing load
SFL = Specified EMT load
σ = Standard deviation

Test result of each sample shall not be less than the specified EMF load. The results (mean value and standard deviation) of thermal-mechanical performance test shall not differ from the results of the ordinary electro-mechanical failing load tests.

In addition, electrical puncture shall not occur before ultimate fracture.

Contract drawings previously submitted to the Employer shall be available at the time of testing.

The Contractor shall give the Employer the requisite period of notice prior to undertaking the tests, and shall submit to the Employer a test program and procedures. **This is a Hold Point.**

Table 9-1: Test Requirements

Test	Insulator Units Cap & Pin (Type B)	Insulator Sets
Type Tests:		
Verification of dimensions	X	-
Dry lightning impulse withstand voltage	X	X
Wet power frequency withstand voltage	X	X
Thermal mechanical performance	X	-
Mechanical or EMF load	X	-
Radio Interference Voltage (RIV)	X	X
Pollution performance		X a)
Power arc	X	X
Impulse voltage puncture	X	-
Zinc sleeve	X	-
Residual strength	X	-
Sample Tests:		

Test	Insulator Units Cap & Pin (Type B)	Insulator Sets
Verification of dimensions	X	-
Verification of locking system and displacement	X	-
Temperature cycle test	X	-
Mechanical or EMF load	X	-
Porosity	X	-
Galvanizing	X	-
RIV	X	-
Impulse Voltage puncture	X	-
Zinc sleeve test	X	-
Head design test	X	-
Routine Tests:		
Visual inspection	X	-
Mechanical	X	-
Electrical	X	-

a) $U_m \leq 245kV$;

9.6.2 Type Tests

(i) Insulator Units

Type test reports issued from independent reputed testing laboratory as listed below, outside the Manufacturer's country for insulator units which shall include the following tests performed on all the offered types of insulators as per IEC except power arc test which shall conform to test procedures outlined in this Clause:

- Verification of dimensions
- Dry lightning impulse voltage withstand test;
- Wet power frequency voltage withstand test;
- Electro-mechanical failing load test;
- Thermal mechanical performance test;
- Radio Interference Voltage (RIV)
- Impulse voltage puncture test
- Power arc test
- Zinc Sleeve Test
- Residual Strength Test

A list of independent reputed testing laboratories acceptable to the Employer is mentioned below:

- KEMA Laboratories in the Netherlands
- Powertech High Power Laboratories in Canada
- Kinectrics, Canada
- IREQ Montreal in Canada
- CESI in Italy
- Vattenfall in Sweden
- Veiki VNL in Hungary

(ii) Insulator Sets

Type tests of insulator sets shall be comprising of cap and pin insulator units being completed with all appropriate same fittings including insulator protective fittings manufactured by the same manufacturer.

The tests of the insulator sets shall be undertaken in accordance with the requirements of IEC 60383-2, to determine the;

(a) Dry lightning impulse withstand voltage,
(b) Wet switching impulse withstand voltage and the power frequency withstand voltage as appropriate,

Following type tests shall also be performed as per the procedure mentioned in this specification:

(a) Radio Interference & Corona test
(b) Power Arc Test

If the type tests for insulator sets are not available as offered combination of insulator & fitting manufacturer (except low duty sets) with proposed design, the tests shall be performed in laboratories mentioned in Clause 9.6.2 (i) during execution stage in presence of Employer's Engineers. Cost of such test and witness shall deem to be included in the Contract Price.

The manufacture shall submit details of the proposed simulation of the support structure and mounting arrangement of the insulator sets to the Employer. **This is a Hold Point.**

Following procedures shall be followed for relevant tests:

1. Radio Interference & Corona

Radio interference type tests shall be under-taken both on single insulator units followed by a complete insulator set test. All radio noise measurements shall be made at a frequency of 1.0 MHz (9 kHz band width), using a radio interference measuring set having a response conforming to CISPR Publication 18. The test circuit shall conform to IEC 60437 and shall be calibrated in-situ to determine any circuit losses. The set shall be adjusted to indicate correctly, or alternatively an appropriate correction (in dB) shall be added to the measurement. Ideally the measurement shall be made using a 300 ohm load resistance. All readings shall be converted to dB above 1μV across 300 ohms, taking into account any corrections necessary.

The test voltage shall be as mentioned in the **Annex 9-2**.

The single unit test voltage shall be that which would appear across the live end unit in the complete set test and shall be determined by an initial voltage distribution measurement.

Before final readings of the radio noise are taken it is permissible to wipe the unit with a dry clean cloth, and to condition it at not more than 50% above the test voltage for up to 2 minutes. This may be repeated if the first measurement exceeds the first level.

The maximum permitted radio noise levels per insulator unit shall not exceed the values stated in **Annex 9-2**.

The number of units tested shall be either 1.5 times the number of units in a complete string or six units whichever is the greater. The choice of set make up to be tested shall be that likely to give the highest voltage across the live end unit with the shortest arc gap. Three pairs of units shall be selected from those previously tested as single units (the most noisy units).

Each pair shall comprise the live end and penultimate live end unit of a single string or the pair of live end units for a duplex string, each pair shall be tested in turn in the set.

The radio noise test voltage and limits shall be in accordance with IEC 60437. None of the tests shall give rise to radio noise levels exceeding the specified limits. Each set shall also be tested for visible corona extinction. Light shall be excluded from the laboratory and the observer's eyesight allowed time to become accustomed to the dark. The voltage shall be increased until corona appears on the string. The voltage shall be gradually reduced until all discharges on the string are extinguished. The extinction voltage shall be measured and the minimum corona extinction voltage shall be as per Annex 9-2. All appropriate action shall be taken to eliminate discharges from test equipment, thereby avoiding spurious corona observations and radio inference readings.

2. Pollution

Artificial pollution tests (salt fog method) in accordance with the requirements of IEC 60507 shall be undertaken.

The salinity of the salt solution and the power frequency withstand voltage shall be in accordance with **Annex 9-3.**

3. Power Arc Tests

a. Power Arc Test for complete Insulator Set.

- Power arc tests to simulate the effect of short circuit current shall be undertaken on the complete insulator set.
- The power arc current shall be in accordance with **Annex 9-2**.
- Acceptance criteria shall be as per IEC 61467.

b. Power Arc Test for Insulator Unit.

- Power arc test shall also be performed to prove the ability of the insulator units to withstand the heat generated by power arc. This test shall be performed in the following manner:
- Nine (9) insulator units of each type shall be chosen for the power arc test. Tests shall be conducted on the above chosen insulator units in three (3) strings of three (3) insulator units each. Strings shall be mounted vertically without arcing horns or conductors. The current and duration of power arc shall be 12kA (symmetrical r.m.s) and 0.1s or 6kA (symmetrical r.m.s) and 0.2 s.
- No shed breakage shall occur during the power arc test. Peeling-off or bum out of glaze on the insulator surface and partial rib chip shall be permitted. If two or more insulator units string break in the power arc test, this insulator design is considered to have failed to meet the specifications. In case one insulator unit fails in the test, re-test on another nine (9) insulator units shall be conducted in the same manner. Failure of anyone unit in the re-test means that the insulator design has failed to meet the specification.

4. Impulse Voltage Puncture Tests

Impulse voltage puncture tests shall be undertaken in accordance with the requirements of IEC 61211.

5. Residual Strength Tests

Residual strength tests shall be undertaken in accordance with the recommendations of IEC 60797. With all the outer shed material removed, the insulator stubs shall be capable of withstanding 80% of the rated minimum failing load for 1 minute.

The test shall be continued to destruction (where it is practicable) to obtain a representative value of the actual falling load, and allow the modes of failure to be determined.

9.6.3 Sample Tests

9.6.3.1. The Contractor shall, give the Employer the requisite period of notice prior to undertaking Sample Tests. **This is a Notification Point.**

9.6.3.2. Sample tests for string insulator (cap & pin) insulator units shall be undertaken in accordance with the requirements of IEC 60383-1, see also Table 9-1.

9.6.3.3. Sample tests in respect of radio noise shall be undertaken on single units only in accordance with the **requirement** of Clause 9.6.2 of this specification. The sample size shall be as per ANSI C29-2 for radio noise test.

9.6.3.4. The **number** of sample to be checked regarding the metallurgical bond of the zinc sleeve to the pin shall be in accordance with IEC 61325.

9.6.3.5. The metallurgical purity of the zinc shall be established by chemical analysis to ensure that any impurities **do** not sensitize the zinc to intergranular corrosion.

9.6.3.6. The zinc sleeve of each sample tested for mechanical strength shall also be inspected according to IEC 61325, to **ensure** no radial and circumferential cracking has occurred.

9.6.3.7. Three insulators shall be selected at random from each lot of the order and their straight head design checked against the straight head design of the manufacturer's cross-section drawing.

9.6.4 Routine Tests

Routine tests for string insulator (cap and pin) insulator units shall be undertaken in accordance with the requirements of IEC 60383-1, see also Table 9-1.

9.6.5 Galvanizing

Tests for galvanized insulator caps, bases and pins shall be carried out at the works to ensure compliance with the requirements of ISO 1461. Details of the test results shall be made available to the Employer upon request.

Certificates relating to the ingot zinc used for galvanizing shall also be made available to the Employer upon request.

9.6.6 Test Certificates

9.6.6.1 All metallic materials used in the manufacture of insulator caps, bases and pins shall be covered by test certificates stating their mechanical, chemical and where specified the impact properties and clearly showing the cast numbers to prove compliance with the requirements of this specification and BS EN 1563, BS EN 1562, BS 970 and BS EN 10084, BS EN 10085 etc., BS EN 515, 573, 586, 603, 606, BS EN 1559, 1676, 1707, BS EN 1172, 1652, 1653, 1654, BS EN 1179 as appropriate.

9.6.6.2 Test certificates for metallic materials and bolts shall be made available to the Employer upon request.

9.6.6.3 Test certificates covering type and sample tests shall be made available to the Employer upon request.

9.6.7 Certificate of Conformity

When requested copies of the following certificates/records shall also be forwarded:

a) Routine test records
b) Metallic material test certificates
c) Galvanizing test records
d) Ingot zinc certificates
e) Metallurgical purity test records for zinc sleeve.

9.6.8 Installation

The Contractor shall be responsible for checking that all insulator sets are complete and that all bolts, split pins and security clips have been correctly installed. A record of this work shall be kept by the Contractor and made available to the Employer upon request.

Annex 9-1: Insulator Types and Uses

1. 132kV Line

Insulator Set Type	Suspension / Heavy Suspension	Tension	Low Duty Tension	Jumper Suspension
Nominal system voltage	132kV			
String configuration	Single	Single	Single	single
Reference drawing				
Insulator unit type	Cap &pin type disc insulator			
Coupling type as per IEC60305	Ball &socket			
Insulating material	Porcelain			
Security clip type	R			
Zinc sleeve	Required			
Head design	Straight head			

2. 132kV Line (River Crossing Portion) – Not applicable

Insulator Set Type	Suspension	Tension
Nominal System Voltage	{…….....132kV…….. .....……}	
String Configuration	Twin	Twin
Reference Drawing		
Insulator Unit type	{.....….....Cap & Pin type disc insulator.....}	
Coupling Type as per IEC 60305	{……..…… Ball & Socket ……..…….}	
Insulating Material	{……..…… Porcelain ……..…….}	
Security Clip type	{…….....……R ……..…..}	
Zinc Sleeve	{…….....Required…….....…..……}	
Head design	{…….....Straight Head…….....……}	

Annex 9-2: Electrical & Mechanical Characteristics

1. 132kV line (ACSR Grosbeak)

Parameter / Insulator Set Type		Suspension/ Jumper Suspension	Heavy Suspension	Tension	Upright Low Duty	Inverted Low Duty
Pollution category		Medium II				
Nominal creepage	mm	2900				
Insulator type		Cap &pin type disc insulators				
Insulator unit reference		U70BL	U120B	U120B	U70BL	U70BL
Glaze colour		Brown	Grey	Grey	Brown	Brown
Unit puncture voltage	kV	110	110	110	110	110
Number of insulator units per string		10	10	11	11	11
Dielectric material		Porcelain				
Dry lightning impulse withstand voltage	kV	650				
Wet power frequency withstand voltage	kV	275				
Power arc for insulator set						
• Current	kA	31,5				
• Duration	s	0.5				
Power arc for string insulator units: Current for duration	kA for s	12 for 0.1 or 6 for 0.2				
Arc gap nominal	mm	1120	1120	1120	1000	1000
RIV level per unit	δB	30				
RIV level per set	δB	40				
Test voltage for RIV & Corona	kV	85				
Mechanical/electromechanical Failing load	kN	70	120	120	70	70

Annex 9-3: Type Test - Pollution IEC 60507

Salt solution salinity	Not required
Remaining Tests	Please refer to this specification

Annex 9-4: Engineering Documents to be Submitted by Contractor

Clause Reference	Document Description	Comment
9.4.1	Insulator units - contract drawings	
9.4.3	Installation procedures	Where necessary
9.4.4	Erection - method statement	
9.6.1	Insulator units - type test certificates	If tests waived
9.6.1	Insulator sets - type test certificates	If tests waived
9.6.1	Type test - programme & procedure	
9.6.1	Details of support simulations	
9.6.5	Galvanising, test results	If requested
9.6.5	Ingot zinc certificates	If requested
9.6.6	Material test certificates	If requested
9.6.6	Insulator units - type test results	
9.6.6	Insulator units - sample test results	
9.6.6	Insulator units - routine test results	If requested
9.6.7	Certificates of conformity	
9.6.8	Installation records	If requested

Annex 9-5: Notification and Hold Points

Clause Reference	Notification Point	Hold Point
9.4.1		Contract drawings
9.4.4		Method statement
9.6.1		Insulators - type tests
9.4.4		Type tests - support simulation details
9.6.8	Insulator - sample tests	

Annex 9-6: Reference Standards

The reference standards and other documents referred to in this section of the specifications are listed below:

IEC 60120:	Dimensions of ball and socket couplings of string, insulator units
IEC 60305:	Characteristics of string, insulator units of cap and pin type
IEC 60372:	Locking devices for ball and socket coupling of string insulator units - Dimensions and tests
IEC 60383:	Insulators for overhead lines with a nominal voltage above 1000V
Part 1:	Ceramic or glass insulator units for ac systems - Definitions, test methods and acceptance criteria
Part 2:	Insulator string and insulator sets for ac - Definitions, test method and acceptance criteria
IEC 60437:	Radio interference tests on high voltage insulators
IEC 60471:	Dimensions of clevis and tongue couplings of string insulator units
IEC 60507:	Artificial pollution tests on high-voltage insulators to be used on a.c. systems
IEC 60672:	Specification for ceramic and glass insulating materials
IEC 60797:	Residual strength of string, insulator units of glass or ceramic, materials for overhead lines after mechanical damage of the dielectric
IEC 60815:	Guide for selection of insulators in respect of polluted conditions
IEC 61211:	Insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1000V - Puncture testing
IEC 61325:	Insulators for overhead lines with nominal voltage > 1000 V
ISO 1461:	Specification for hot-dipped galvanizing coating on iron and steel articles
BS EN 10084:	Specification for wrought steel for mechanical and applied Engineering purposes
BS EN 10085; BS EN 10087; BS EN 10095; BS EN 10250; PD 970; BS EN 515:	Specification for wrought aluminium and aluminium alloy
BS EN 573; BS EN 586; BS EN 603; BS EN 604; BS EN 1559:	Specification for Aluminium and aluminium alloy ingots and casting for general engineering purposes
BS EN 1676; BS EN 1706; BS EN 1172:	Specification for Rolled Copper and Copper Alloys: Sheet, strip and foil
BS EN 1652; BS EN 1653; BS EN 1654; BS EN 1563	Spheroidal graphite cast iron

BS 4190:	Specification for ISO metric hexagon bolts, screws and nuts
BS 5252:	Framework for colour coordinations of buildings
BS EN 1562	Specification for malleable cast iron
BS EN 1179:	Specification for Zinc & Zinc Alloys
BS EN 1676:	Aluminium & aluminium alloys - Alloyed ingots for re-melting
CISPR:	Publication 1 Specification for CISPR radio interference measuring apparatus for the frequency range 0.15 to 30 MHz.
BS EN 50341-1:2012:	Overhead electric lines exceeding AC 1 kV - Part 1: General requirements - Common specifications

10. Insulator and Conductor Fittings

10.1 Scope

10.1.1 Types and Uses

The type and arrangement of all insulator and earthwire sets inclusive of all insulator and earthwire set fittings, suspension clamps, conductor tension fittings and insulator protective devices shall be approved. Please refer to **Annex10-1, Annex10-2 and Annex10-3** for details of the specific requirements.

10.2 Design

10.2.1 General

10.2.1.1. All insulator and conductor fittings shall be designed so as to:

a. avoid damaging the conductor under all service conditions;
b. withstand the mechanical loads relevant to the installation-service-maintenance conditions, the design service current including short circuit effects, the service temperature and environmental effects;
c. be free from visible and audible corona discharge and radio interference at the voltage levels specified, except those designed exclusively for use on earthwires;
d. minimize the number of parts and the possibility of incorrect assembly and installation;
e. ensure that individual components are secured against becoming loose in service, and all threaded fasteners shall be locked;
f. Compression fittings after compression shall not permit relative movement between the individual layers of the conductor.
g. from material, which have sufficient strength, ductility and environmental resistance to withstand the static and dynamic loading.

10.2.1.2. Where appropriate insulator and conductor fittings shall be in accordance with the requirements of IEC 61284. Ball and socket coupling shall be in accordance with the requirements of IEC 60120. Socket fitting shall be designed for 'W' type security clips or 'R' type security pins in accordance with the requirements of IEC 60372 as appropriate, clevis tongue couplings shall be in accordance with the requirements of IEC 60471.

10.2.1.3. All factory formed helical fittings shall be performed with a right hand lay and shall completely enclose the conductor except for small gaps required to ensure that all rods make good contact with the conductor over their entire length.

10.2.2 Live-Line Working

Where live-line working is specified in **Annex 10-1** the design of the fittings shall take into account the following requirements:

a. both suspension and tension insulator sets shall include either clevis fittings, or yoke plates incorporating cut-outs correctly dimensioned suitable for live-line working;
b. the minimum distance between the attachment point and the shoulder for clevis fittings shall not be less than 125 mm, where no yoke plate is adjacent;
c. clevis and tongue and clevis-clevis connections shall be provided with 'R' type security pins;
d. insulator protective devices attached to yoke plates shall utilise captive bolts.

10.2.3 Sag Adjusters

All tension insulator sets shall incorporate sag adjusters for adjusting the sag of either Individual phase conductors or sub-conductors forming a phase conductor bundle. The total range of linear adjustment and individual steps shall be as specified in **Annex 10-1**.

When specified low-duty tension insulator sets shall incorporate a turnbuckle for adjusting the sag of the complete downlead. The turnbuckle where appropriate shall comply with the requirements of BS 4429 and shall be fitted with locknuts. The total range of linear adjustment shall be as specified in **Annex10-1.** The turnbuckle shall be fitted in the earth end of the low duty tension insulator set.

10.2.4 Insulator Protective Fittings:

10.2.4.1 The design of insulator protective fittings including corona shields shall comply with the following requirements:

a. shall effectively protect the insulator units, and the fittings from damage caused by power arcs;
b. shall effectively improve the voltage distribution along the insulator string;
c. shall effectively improve the corona performance of the insulator set;
d. shall be designed in such a way as not to be subject to breakage fatigue due to wind induced vibration;
e. shall withstand a specified mechanical load.

10.2.4.2 For details of the materials, workmanship and quality control requirements for insulator protective fittings reference shall be made to clauses10.3, 10.4&10.6 of this Section 10.

10.2.4.3 The end of all arcing horns shall be formed into smooth hemispheres. The end of tubular arcing horns shall also be sealed.

10.2.5 Electrical and Mechanical Characteristics

The insulator and earthwire set fittings, suspension clamps, conductor tension fittings and insulator protection devices shall have the electrical and mechanical characteristics specified in **Annex 10-1, Annex 10-2 and Annex 10-3.**

10.2.6 Suspension Clamps

Suspension clamps shall be designed to meet the following requirements:

a. so that the effects of vibration both on the conductors, or the earthwire and on the clamp themselves are minimised;
b. to avoid localised pressure or damage to the conductor or earthwire, and shall have sufficient contact surface to avoid damage by fault currents;
c. shall be free to pivot in the vertical plane of the conductor/earthwire and shall have a minimum range of movement of plus or minus 30 degrees;
d. shall have a slipping capacity between specified minimum and maximum slipping loads so as to meet the requirement of Clause10.6.2.2 of this specification;
e. suspension clamp assemblies shall have sufficient strength and durability to prevent deterioration in service;
f. The mouth of the suspension clamp shall be rounded and slightly flared, with a minimum radius of curvature in the vertical plane of 150 mm.

10.2.7 Earthwire Suspension Clamps

Where specified earthwire suspension clamps and all suspension clamps for use with earthwire with embedded optical fibre cable and ADSS optical fibre cable shall be of the armour grip type, generally in accordance with the requirements of Clause 10.6.2.2, except that they shall be capable of being used in conjunction with factory formed helical armour rods and neoprene liners.

10.2.8 Counterweights

When specified, counterweights shall either be fitted below the suspension clamp by extension of the clamp-keeper retaining bolts, by attachment to the yoke plate, or by replacement of the complete assemblies for multi-bundled conductors for use with pilot suspension insulator sets.

Where the complete clamp assembly is replaced, the counterweight shall be fitted with permanently bonded aluminium liners and all retaining bolts, nuts and washers shall not protrude beyond the cylindrical section of the weight.

10.2.9 Connectors and Joints

Connections and joints shall be designed to meet the following requirements:

a. that after installation the initial contact area of the fitting to the conductor or earthwire does not raise stresses which may lead to failure under aeolian vibration or other conductor oscillation conditions;
b. localized pressures which may cause excessive cold flow of the conductor or earthwire shall be avoided;
c. to minimize internal voids and to prevent the ingress of moisture during service;
d. full tension joints (dead ends and mid-spans) shall not permit slipping of, or cause damage to, or failure of the complete conductor or any part thereof at a load less than 95% of the rated ultimate strength of the conductor;

e. non tension joints and connectors shall not permit slipping of, or cause damage to the conductor at a load less than 25% of the rated ultimate strength of the conductor;
f. those connectors and joints with auxiliary eyes intended for use during construction or maintenance shall be marked with the specified minimum failing loaded stated by the manufacturer.

10.2.10 Tee Connector

Tee connectors shall be as specified either interlocking compression type or bolted type.

10.2.11 Full Tension Joints (Dead End)

Full tension joints (dead end) shall be of the following types:

a) Compression

Compression dead ends shall have either integral jumper terminals or jumper terminal flags for use with bolted jumper palms. Integral jumper terminals shall either be straight or 30 degree line type.

b) Bolted

Bolted dead ends shall be designed to ensure that once the bolts have been tightened to the manufacturer's recommended torque, no slackening of the clamp can occur.

c) Wedge

Wedge clamps shall be designed with the attachment straps. The body and the wedges shall be of forged aluminium alloy. The body shall be hinged and the design shall incorporate dovetail interlocking wedges and body. The performance of the clamp shall be unaffected by manufacturing tolerances in the wedges and the bodies. The design of the conductor guide assembly shall ensure that it is possible to tighten the bolts with the wedge clamp straps assembled in their correct position.

d) Factory Formed Helical

For details of the exact requirements reference shall be made to **Annex 10-3.**Helical dead ends for earthwires or ADSS optical fibre cables shall be supplied complete with solid thimbles in accordance with the requirements of BS EN 1311-1.

10.2.12 Full Tension Joints (Mid-Spans)

Full tension mid-span joints shall be of the compression type, joints for metallic conductors shall include a longitudinal centering key. Joints for mono-metallic conductors shall include a central barrier stop to ensure correct longitudinal centering of the joint.

10.2.13 Non-Tension Joints

Non-tension joints shall be of the following types:

a) Disconnectable

Disconnectable joints shall comprise two identical straight palms, and shall be supplied complete with bolt assemblies. Bolt assemblies shall consist of bolts and nuts, grade 8.8/8 in accordance with BS 4190 complete with load spreading washers.

b) Non-disconnectable

Non-disconnectable joints shall be of the compression type.

c) Jumper Palms

Jumper palms for connecting jumper loops to dead ends, or tee connectors shall be of the compression type with either straight or 30 degree lugs. Bolt assemblies shall be in accordance with requirements specified for disconnectable joints.

10.2.14 Repair Sleeves

Repair sleeves shall be either compression types, or factory formed helical type. The compression type shall be two part interlocking sleeve or key type. Reference shall be made to Annex 10-3 for the specified requirements.

Repair sleeve shall be designed to make good a conductor of which not more than one-third of the strands of the outermost layer have been severed.

10.2.15 Line Termination Fittings

Line termination fittings shall be either bimetallic or aluminium. Bi-metallic fittings shall be designed to prevent corrosion between dissimilar metals, they shall include both a waterproof barrier at the end of the compression termination and a waterproof joint adjacent to the substation equipment terminal.

Reference shall be made to **Annex 10-3** for the specific requirements.

10.2.16 Armour Rods

Armour rods shall be of the factory formed helical type and comprise sets of individual rods compatible with the conductor. The rods shall completely enclose the conductor except for small gaps required to ensure that all the rods make good contact with the conductor over the entire length.

10.2.17 Jumper Weights

Jumper weights for multi-bundled phase conductors shall be fitted with permanently bonded aluminium liners, and all retaining bolts, nuts and washers shall not protrude beyond the section of the weight.

10.2.18 Tubular Jumpers

Tubular jumpers where specified shall be supplied complete with integral compression jumper terminals. Earthing bars for tubular jumpers shall have captive locking bolts opposite to the hinge bolt. The earthing bar shall be of solid aluminium rod.

10.2.19 Earthwire Bonding Clamps

Earthwire bonding clamps for the connection of flexible earthwire bonds to the earthwire shall be explosively applied wedge tap assemblies C-type, in accordance with the requirements of BS EN 61238-1 Part 3. For OPGW termination positions the C-type connectors shall be complete with a lug. The lug shall have a 18 mm diameter hole.

10.2.20 Earthwire Bond

Earthwire bonds shall be manufactured from multi-strand, multi-wire fatigue resistant aluminium alloy to BS EN 50183, with a minimum nominal cross sectional area of 100mm². The overall bond and individual strands shall be thoroughly greased with an approved conductor grease (see clause 11.3.2), before being covered by an extruded flexible PVC sheath, of minimum thickness 1.5 mm.

The bond shall be fitted with either a compression type lug or a compression type pin 20 mm diameter as appropriate. Compression lugs shall accommodate either M 16 or M 12 bolts.

10.3 Materials

10.3.1 Insulator and Conductor Fittings

10.3.1.1. Materials used in the manufacture of insulator and conductor fittings shall be of:

a. adequate strength for the intended application and service life requirements (including mechanical loads, vibrations, electrical currents and environmental effects) and free from defects which would affect the performance of the fitting;
b. shall not be liable to intergranular or stress corrosion;
c. the materials of compression fittings shall be capable of withstanding the cold working of the material due to compression;
d. steel compression components shall have sufficient impact strength after compression;
e. compatible with the conductor material, or capable of being used with an intermediate material such that there can be no deterious effects on the conductor, or fittings resulting from their use;
f. the material shall not be adversely affected in the long term by a coating applied for corrosion protection.

10.3.1.2. All phase conductor fittings shall have aluminium or aluminium alloy only in contact with the phase conductor.

10.3.1.3. All mild and high tensile steel used in the manufacture of insulator and conductor fittings including suspension saddles shall comply with the requirements of BS EN 10025. Minimum steel grades shall be S275JR and S355JO for mild and high tensile steel respectively.

10.3.1.4. Tubular steel used in the manufacture of insulator protective fittings shall be medium steel complying with requirements of BS 1387. Forged steel fittings shall be made from steel of suitable grade, complying with the requirements relating to the inter-crystalline corrosion tests of BS 970: Part 1.

10.3.1.5. Malleable cast iron fittings shall be made from white heart or pearlitic MCI or spheroidal graphite MCI of a suitable grade complying with the requirements of BS EN 1562 or BS EN 1563 respectively.

10.3.1.6. Forged aluminium and aluminium alloy fittings shall be made from aluminium or aluminium alloy of a suitable grade, complying with the requirements of BS EN 515, 573, 586, 603 and 604.

10.3.1.7. Cast aluminium and aluminium alloy fittings shall be made from aluminium or aluminium alloy of a suitable grade, complying with the requirements of BS EN 1559, 1676 and 1706.

10.3.1.8. Twin-single bridging plates shall be manufactured from 99.9% pure EC grade aluminium.

10.3.1.9. Bolts and nuts shall be either ISO metric black hexagon to BS 4190, and shall unless otherwise specified be threaded ISO metric course pitch to BS 3643: Part 2, tolerance class 7h/8g, or ISO metric precision hexagon to BS 3692.

10.3.1.10. Flat washers shall either comply with the requirements of BS 4320, form E, grade 4.6, or ISO metric to BS 4320, 'bright series'. Spring washers shall be ISO metric to BS 4464.

10.3.1.11. Split pins including 'R' type security pins shall comply with the requirements of BS 1574 and IEC 60372 respectively, and shall be of austenitic stainless steel capable of complying with the requirements relating to the inter-crystalline corrosion tests of BS 970: Part 1 and BS EN 10084, 10085, 10087, 10095, 10250 and PD 970.

10.3.1.12. Security 'W' clips shall be of phosphor-bronze composition in accordance with BS EN 1172, 1652, 1653 and 1654, and supplied in half-hard condition with a minimum hardness of 155 VPN.

10.3.1.13. Non-metallic materials used shall have:

a. good resistance to ageing;
b. capable of withstanding service temperatures without detrimental change of properties;
c. adequate resistance to the effects of nitrogen oxides, ozone, ultra-violet radiation and air pollution over the whole range of service temperatures.

10.3.2 Oxide Inhibiting Compound

Compression fittings shall be filled with oxide inhibiting compounds prior to despatch from the manufacturers with the ends of the fittings temporarily protected. The quantity of oxide inhibiting compounds shall be sufficient to ensure the integrity of the fitting.

Where grease is used as an oxide inhibiting compound, it shall be of a neutral soft type with a high melting point, and shall be in accordance with the requirements of Clause 11.3.2.

10.4 Workmanship

10.4.1 General

10.4.1.1. The dimensions of all insulator and conductor fittings shall be shown on the contract drawings, together with material types and grades, protective treatment and any other pertinent information. Contract drawings shall be submitted to the Employer. **This is a Hold Point.** Particular regard shall be paid to those dimensions which involve interchangeability, correct assembly and those for which gauges are specified. Tolerances where appropriate shall be in accordance with the requirements of IEC 60372 or IEC 60471.

10.4.1.2. All castings shall be free from flaws, blowholes and shall be of a closed-grained quality. No repair of any casting shall be carried out without the approval of the Employer. **This is a Hold Point.**

10.4.1.3. The welding of all ferrous metals shall be carried out in accordance with BS EN 1011.

10.4.1.4. For river crossing suspension saddles all welding shall be undertaken in accordance with Clause 8.7.2. Inspection levels shall be level 4 or 5 as appropriate for fillet and butt welds, except that 100% of each welder's output shall be tested.

10.4.1.5. Ball ended fittings shall be free from cracks, surface flows, laminations and other defects.

10.4.1.6. Fittings shall be free from sharp edges, burrs and swarf, particular attention shall be paid to insulator protective devices to prevent corona in service. The faces of flat faced fittings shall be sufficiently parallel and flat to provide a suitable contact service and shall remain so after fabrication. In addition care shall be taken to remove any surface contaminates prior to packing, other than material introduced by the manufacturer as a protective measure.

10.4.1.7. The mouth of suspension and top (trunnion) clamps, counterweight, wedge and bolted jumper weight clamps shall be free of sharp radius of curvature, ridges or other irregularities which may lead to localised pressure or damage to the conductors, or the separation of individual strands.

10.4.1.8. Factory formed helical fittings shall have rounded ends, when used with ADSS optical fibre cable the ends shall be relieved.

10.4.2 Identification and Marking

All insulator and conductor fittings shall be marked to ensure a system of traceability for each component part of the fittings. Where practicable, and unless otherwise agreed between the Engineer and the manufacturer, fittings shall be clearly and indelibly marked with minimum 3 mm high characters as follows:

a. Identification of fitting (reference number/specified minimum failing load);
b. Maker's identification;
c. Date of manufacture (month and year);
d. Cast code - if appropriate;
e. Conductor size or diameter range or code name - if appropriate;
f. Fitting bolt installation torque - if appropriate;
g. Compression die size - if appropriate;

h. Length and direction to be compressed - if appropriate.

In the case of factory formed helical fittings, the information as required above shall be provided on tear-off labels; additionally they shall be marked with paint to an agreed colour code either at the cross-over point or at the centre of the fitting.

10.4.3 Installation Criteria

10.4.3.1 The supplier shall provide comprehensive instructions in a suitable format covering the selection and installation, including the installation torque of any bolt, compression die sizes and direction of compression.

10.4.3.2 Installation instructions shall include directions for the use of any additional materials to the fittings, including the selection of such materials and of the conductor preparation.

10.4.3.3 Joints and connectors intended for the restoration of electrical and mechanical properties of a conductor, shall have clearly defined manufacturer's instructions as to the extent of the damage which they are intended to repair.

10.5 Protective Treatment

10.5.1. All parts of insulator and conductor fittings shall be either inherently resistant to atmospheric corrosion or suitably protected against corrosion, such as may occur in transit, storage and in service. All ferrous parts which will be exposed to the atmosphere in service, except those made in appropriate stainless steel, shall be protected by hot-dipped galvanizing to comply with the requirements of BS ISO 1461. All manufacturing processes shall be completed prior to galvanizing.

10.5.2. The ingot zinc used for galvanizing shall comply with the requirements of BS EN 1179.

10.5.3. All external threads shall be cut or rolled before hot-dipped galvanized. Nuts to be galvanized shall be subsequently tapped 0.4 mm oversize with the threads oiled.

10.5.4. Where tubular steel insulator protective fittings are provided with galvanizing vent-holes, these holes shall be effectively plugged after galvanizing with zinc plugs.

10.5.5. The rough machined surfaces of bolted palm joints and aluminium line termination fittings shall be protected with a removable dry waterproof coating.

10.5.6. All galvanized materials shall be stored on packing, clear of the ground and away from all materials that might stain or corrode the galvanizing. Black steel packing or bin shall not be used.

10.6 Quality Control

10.6.1 General

10.6.1.1 Type, sample and routine tests shall be undertaken on insulator and conductor fittings in accordance with the requirements of this specification. Type and sample test requirements are detailed in Table 10-1. In addition to these tests Visual, Dimensional and Galvanizing tests are to be done during Type test and Sample test as per requirement of IEC 61284. Type tests specified in Table 10-1 shall be undertaken on a minimum of three samples, which shall be identical in all essential details, with the fittings to be supplied. Heat cycle tests shall be undertaken on four samples.

10.6.1.2 Contract drawings previously submitted to the Employer shall be available at the time of testing. The Contractor/Supplier shall give the Employer the requisite period of notice prior to undertaking the tests and shall submit to the Employer a test programme and procedures**. This is a Hold Point.**

10.6.1.3 In addition to the tests specified, when required by the Employer, type tests shall be undertaken on complete insulator sets. For details of these tests reference should be made to Section 9 of this specification.

Table 10-1: Type and Sample Test Requirements

Fitting	Name of Test					
	Mechanical	Resistance	Heat Cycle	Corona	Bolt Torque	Conductor Damage
Insulator set fittings	TS			T		
Earth set fittings	TS					
Insulator protective fittings	TS			T		
Suspension clamps	TS			T	TS	TS
Earthwire suspension clamps	TS				TS	TS
Counter weights				T	T	T
L.P.I. top (Trunnion) clamps	TS			T	T	T
Earthwire top (Trunnion) clamps	TS				T	T
Tee connectors (compression)	TS	TS	T		TS	
• (bolted)	TS	TS	T			
Tension joints (dead ends)						
• Compression	TS	TS	T	T		
• Bolted	TS		T	T	TS	TS
• Wedge	TS		T	T	TS	TS
• Helical	TS		T	T		TS
Tension joints (mid-span)						
• Compression	TS	TS	T			
Non-tensile joints						
• Disconnectable	TS	TS		T		
• Non-disconnectable	TS	TS		T		
• Jumper palms	TS	TS			TS	
Repair sleeves						
• Compression	TS	TS				

Fitting	Name of Test					
	Mechanical	Resistance	Heat Cycle	Corona	Bolt Torque	Conductor Damage
• Helical	TS	TS				
Line termination fittings	TS	TS				
Armour rods						T
Jumper weights						TS
Tubular jumpers	TS	T		T		
Earthwire bonding clamps						T
Earthwire bonds		TS				

T = Type Tests, S = Sample Tests

10.6.2 Test Procedure

Each fitting shall withstand its specified minimum failing load for one minute, and shall be tested in a manner as far as practical to that in service. One sample shall if practical be taken to failure and the mode of failure recorded.

10.6.2.1 Insulator Protective Fittings

Insulator protective fittings shall be mechanically tested to withstand the specified loads for 1min without failure. A force of 1.8 kN shall be applied to the tip of suspension arc horns, and 0.9 kN to tension arc-horns. The direction of the force shall correspond to that which would be applied by a linesman with the insulator set in service.

10.6.2.2 Conductor/Earthwire Suspension Clamps

a) Tensile Test

The clamp supported by its trunnions as appropriate shall be installed at its recommended installation torque on a rigid bar of a suitable size and mounted, complete with the suspension straps, in the testing machine. A tensile load equal to half its specified minimum failing load applied to 90 degrees to the conductor axis at each side of the clamp. The load shall be steadily increased. This load shall be kept constant for 60 s. No failure shall occur after application of specified minimum failure load for 60 seconds..

b) Conductor Slip Test

A length of conductor shall be fitted into the clamp as per IEC 61284 and the clamp bolts tightened to the recommended torque. An axial tensile force shall be applied either to the conductor, or the clamp. The conductor shall not slip through the clamp below a load of 7kN or 5% of the nominal breaking load of the conductor, whichever is the greater value. The conductor shall slip through the clamp at a load not greater than 30% of the conductor minimum breaking load. The conductor shall not be damaged, other than some flattening of the strands.

10.6.2.3 Tension Joints, Tee Joints and Sleeves

The fitting shall be assembled in accordance with the manufacturer's instruction on conductors of the size and type with which it is to be used. The assembly shall be mounted in a tensile testing machine, the end fixings of the conductor shall be such as to prevent bird-caging or slipping of the individual strands. The length of conductor between fittings under test and any other clamp or joint in the test assembly shall not be less than 100 times the overall diameter of the conductor or 2.5m, whichever is less.

Compression type joints shall be assembled as per IEC 61284 on conductors of the size and type with which it is to be used. Load shall be applied as per IEC 61284 [alternative a]. The test shall be passed if no movement of the conductor relative to the joint/clamp and no failure of the joint/clamp or conductor occurs at or before the end of the application of the Specified Minimum Failure Load (≥95% of RTS of Conductor) for 60s.

For factory formed helical tension terminations, the fitting shall be assembled in accordance with the manufacturer's instructions. A tensile load of 40% of the conductor breaking load shall be applied and maintained for 1min. The load shall be relaxed and the fitting removed. The fitting shall be reapplied and the test repeated, after subsequent removal and replacement the test shall be continued as detailed above. Specified Minimum Failure Load shall be ≥95% of RTS of Conductor and shall be applied for 60s.

For wedge clamps the test shall be carried out on a maximum size body and minimum size wedges and on a minimum size body and maximum size wedge. The maximum and minimum sizes shall be defined by the Manufacturer.

The following additional requirement shall be applicable to wedge clamps:

- A 5 kN load shall be applied to the assembly and the position of the wedges relative to the clamp body recorded;
- Loads of 20, 30 and 40% of the conductor's nominal breaking load shall be applied to the conductor and the relative position of the wedges recorded. After the application of each load the torque on the wedge and conductor guide bolts shall be removed and no conductor slip, shall occur. After 40% of the load when the wedge bolts are released to check for no slip, it shall then be confirmed that the wedges and body may be separated with the recommended extractor tool;
- The number of strands severed for repair sleeves shall be the nearest whole number to one- third of the total number of strands in the outermost layer and shall be severed at a uniform spacing along the conductor;
- A tensile load of 50% of the breaking load of the conductor shall be applied and the conductor marked so that any relative movement of the fitting can be easily detected. Without any subsequent adjustment of the fitting, the load shall be increased to 95% of the breaking load and then reduced to 90% and held for 1min. There shall be no movement of the conductor relative to the fitting due to slip during this period of 1min and no failure of the fitting.

For tests on OPGW and ADSS fittings there shall be no degradation in the fibre optic signal strength after the completion of the test. The signal strength shall be measured using an OTDR.

10.6.2.4 Non-Tension Joints, Line Termination Fittings and Tubular Jumpers

A tensile load of 0.6kN shall be applied and the conductor marked so that any relative movement of the fitting can be easily detected. Without any subsequent adjustment of the fitting, the load shall be increased to 10% of the conductor's nominal breaking load and this load held for 1min. There shall be no movement of the conductor relative to the fitting due to slip during this period and no failure of the fitting.

10.6.2.5 Compression Fittings

All compression fittings after installation in accordance with the manufacturer's instructions shall remain straight after compression.

10.6.2.6 Resistance

The fitting shall be assembled in accordance with the manufacturer's instruction on a length of conductor. The electrical resistance shall be measured between two points on the conductor on either side of and immediately adjacent to, the fitting. The test shall be made with direct current. The current connections shall be at a distance of not less than 50 times the conductor diameter from the fitting. A micrometer having an accuracy of 0.1% with current reversal and averaging shall be used for measurement. The measured resistance shall not exceed 75% of the equivalent length of conductor.

10.6.2.7 Heat Cycle

Heat cycle tests shall be undertaken in accordance with the requirements of IEC 61284.

10.6.2.8 Current Pulse

In addition to the heat cycle test described in clause 10.6.1, non-tension fittings shall be subject to the current pulse test undertaken in accordance with the requirements of IEC 61284.

The test assembly shall be so arranged that current is passed through the fitting from the main conductor to the jumper conductor on tension joints (dead ends) and from the main conductor to the tee conductor on the tee joints.

10.6.2.9 Corona and RIV

All fittings, other than those used exclusively for earthwire application shall be erected as in service, (which may necessitate representation of the tower body) and subjected to a visible corona and RIV test. The test shall be undertaken in accordance with the requirements of IEC 61284.

10.6.2.10 Bolt Torque

The test shall be performed as per IEC 61284. The bolts shall be tightened to twice the recommended torque on the conductor. No damage shall occur to the fitting or its bolts at less than this torque.

10.6.2.11 Conductor Damage

The fitting shall be installed on the conductor and where appropriate the bolts tightened to the recommended torque. In the case of factory formed helical fittings, these shall be checked to ensure that the rods make contact with the conductor over their entire length. The position of the fitting shall be

marked and then removed from the conductor. No indentations in the outer strands of the conductor shall be present in the area of the fitting.

10.6.2.12 Galvanizing

Tests for galvanizing conductor and insulator fittings shall be carried out at the works to ensure compliance with the requirements of BS ISO 1461. Details of the tests results shall be made available to the Employer upon request.

Certificates relating to the ingot zinc used for galvanizing shall also make available to the Employer request.

10.6.3 Sample Tests

10.7.13.1. Sample tests identical to type tests shall be undertaken as indicated in Table 10.1. In addition, verification of compliance with the 'contract drawings' and surface finish compatible with the reference fitting shall also form part of the sample test.

10.7.13.2. The Contractor shall give the Employer the requisite period of notice prior to undertaking Sample Tests. **This is a Notification Point.**

10.7.13.3. The number of samples selected for test shall be in accordance with the following requirements, where 'p' is the numbers of fittings to be tested, and 'n' is the number of fittings produced in a batch.

p = 1 when 25 < n ≤ 50
p = 2 when 50 < n ≤ 75
p = 3 when 75 < n ≤ 100
p = 4 when 100 < n≤ 500
p = 4 + 1.5n/1000 when n > 500

10.7.13.4. If the randomly selected samples meet the test requirement, the batch(es) shall be deemed to comply with Specification. In the event of any sample not meeting this requirement, a further set of 'p' samples shall be tested. Should any further failure occur the whole batch(s) from the samples have been selected shall be liable to rejection.

10.6.4 Routine Tests

Unless otherwise specified routine mechanical tests shall be undertaken on insulator set and suspension clamp castings and those fittings in which a weld is subject to service load, insulator protective fittings and tension joints.

All fittings, tested shall be subjected to the routine test load of 50 percent of the specified minimum failing load. The application of the test load for 30 seconds shall not cause any permanent deformation or damage

10.6.5 Test Certificates

10.7.16.1. All metallic materials used in the manufacture of conductor and insulator fittings shall be covered by test certificates stating their mechanical, chemical and where specified the impact properties and clearly showing the cast numbers, to prove compliance with the requirements of this specification and BS EN 10025, BS 970 and BS EN 10084, 10085, 10087, 10095, 10250, PD 970, BS EN 1562, BS EN 1563, BS EN 515, 573, 586, 603, 604, BS EN 1559, 1676, 1706, BS EN 1172, 1652, 1653, 1654, BS EN 1676 as appropriate.

10.7.16.2. Test certificates for metallic materials and bolts and nuts shall be made available to the Employer upon request.

10.7.16.3. Test results covering type and sample tests shall be made available to the Employer.

10.7.16.4. Test results covering routine tests shall be made available to the Employer upon request.

10.6.6 Certificates of Conformity

When requested copies of the following certificate/records shall also be forwarded:

a) Routine test records
b) Metallic materials and nuts/bolts test certificates
c) Galvanizing test records
d) Ingot zinc certificates.

Annex 10-1: Insulator Sets / Fittings - Types and Uses

Insulator Fittings - Types & Uses - 132kV (ACSR Grosbeak or equiv. dia. ACCC)

Insulator Fittings Type	Suspension	Heavy Suspension	Tension	Low Duty	Pilot Suspension
Reference drawing					
Set configuration	Single	Single	Single	Single	Single
No. of insulator strings	1	1	1	1	1
Min. separation between centres of parallel strings (mm)	-	-	-	-	-
Coupling type	Ball & Socket	Ball & Socket	Ball & Socket	Ball & Socket	Ball & Socket
Security clip type	R	R	R	R	R
No. of sub-conductor	1	1	1	1	1
Sub-conductor spacing (mm)			-	-	-
Live line working	Required	Required	Required	Not Required	Required
Sag adjuster type	-	-	Quadrant	Turnbuckle	-
Linear range (mm)	-	-	75 - 225	230	-
Increment (mm)	-	-	-	-	-
Overall set length (mm)	2000	2000	2400	2350 (A) 2900 (B)	1950
Min. failing load complete set					
• Common to all conductor (kN)	70	120	120	70	70
• Common to individual Conductor (kN)	70	120	120	70	70
Insulator protective devices: Type					
• Live end	Single Point	Single Point	Single Point	Single Point	Single Point
• Earth end	Single Point	Single Point	Single Point	Single Point	Single Point

(A) Upright (B) Inverted

Annex 10-2: Earthwire/OPGW Sets - Types & Uses

Annex 10-2(1): 132kV (Overland Portion)

Earthwire/OPGW Set Type	Suspension	Tension
Reference drawing		
Overall set length (mm)	350	700
Min failing load complete set (kN)*	70	120

* - Strength may be modified subjected to the Approval during Execution.

Annex 10-3: Conductor Joints & Clamps - Types & Uses

132kV (Overland Portion)

Joint & Clamp Type	Phase	OPGW	Earthwire
Conductor	ACSR Grosbeak or equiv. dia ACCC	7 x 3.25 GS equiv.	7 x 3.25 GS Earthwire.
Suspension clamp type	Trunnion Corona free	Armour Grip	Trunion
Armour rods	Preformed type-required for heavy suspension set	Required	Not required
Counterweights (kg)	50		
Tension joints:			
• Dead end type	Compression	Helical	Compression
• Jumper terminal type	Compression		
• Mid-spans type	Compression		Compression
• Repair sleeves type	Compression		Compression/Helical
• Tee connectors type	Compression		Compression
Non-tensile joints:			
• Disconnectable			
• Non-disconnectable			
Jumper palms type	Bolted 0° & 30°		
Line termination fittings type			
Jumper weights (kg)			
Tubular jumpers			
Earthwire bonds end fitting type		Lug-lug	Lug-lug

Annex 10-4: Engineering Documents to be Submitted by Contractor

Clause Reference	Document Description	Comment
10.4.1	Insulator &conductor fittings - contract drawings	
10.4.3	Installation procedures	
10.6.1	Insulator &conductor fittings - type test certificate	If requested
10.6.1	Type test - programme & procedures	
10.6.2.12	Galvanizing test results	If requested
10.6.5	Ingot zinc certificates	If requested
10.6.5	Metallic & bolt/nuts material test certificate	If requested
10.6.5	Insulator &conductor fittings - type test results	
10.6.5	Insulator &conductor fittings - sample test results	
10.6.5	Insulator &conductor fittings - routine test results	If requested
10.6.6	Certificates of conformity	

Annex 10-5: Notification and Hold Points

Clause Reference	Notification Points	Hold Points
10.4.1		Contract drawings
10.6.1		Insulator and conductor fittings - type tests
10.6.3	Insulator &conductor fittings - sample tests	

Annex 10-6: Reference Standards

The reference standards and other documents referred to in this section of the specifications are listed below:

IEC 60120:	Dimensions of ball and socket couplings of string insulator units
IEC 60372:	Locking devices for ball and socket couplings of string insulator units Dimensions and tests
IEC 60471:	Dimensions of clevis and tongue couplings of string insulator units
IEC 61284:	Overhead lines Requirements and tests for fittings
BS EN 13411	Specification for thimbles for wire rope
BS EN ISO 1461	Specification for hot-dipped galvanising coating on iron and steel articles
BS 970:	Specification for wrought steel for mechanical and applied engineering purposes
BS EN 10084; BS EN 10085; BS EN 10087; BS EN 10095; BS EN 10250; PD 970; BS 1387:	Specification for screwed and socketed steel tubes and tubular and for plain end steel tubes suitable for welding or screwing to BS 21 pipe threads
BS EN 515:	Specification for wrought aluminium and aluminium alloy
BS EN 573; BS EN 586; BS EN 603; BS EN 604; BS EN 1559:	Specification for aluminium and aluminium alloy ingots and castings for general engineering purposes
BS EN 1676; BS EN 1706; BS 1574:	Specification for split cotter pins
BS EN 1563:	Specification for spheroidal graphite cast iron
BS EN 1172:	Specification for rolled copper and copper alloys: Sheet strip and foil
BS EN 1652; BS EN 1653; BS EN 1654; BS EN 50183	Aluminium alloy stranded conductors for overhead power lines
BS 3643:	ISO Metric threads
Part 2:	Limits and tolerances for course pitch series threads
BS 3692:	Specification for ISO Metric Precision hexagon bolts, screws and nuts
BS 4190:	Specification for ISO Metric hexagon bolts, screws and nuts
BS 4320:	Specification for metal washers for general engineering purposes. Metric series
BS 4429:	Specification for rigging screws and turnbuckles for general engineering, lifting purposes and pipe hanger applications
BS 4464:	Specification for Spring Washers for general engineering and automobile purposes. Metric series.

BS 4579:	Part 3 Performance of Mechanical and Compression Joints in Electric Cables and Wire Connectors
BS EN 1011:	Specification for arc welding of carbon and carbon manganese steel
BS EN 1562:	Specification for Malleable cast iron
BS EN 1676:	Aluminium and aluminium alloys - Alloyed ingots for remelting.
BS EN 1179:	Zinc and Zinc Alloys.
BS EN 10025:	Specification for hot rolled products of non-alloy structural steels and their technical delivery requirements.
BS EN 50341-1: 2012	Overhead electric lines exceeding AC 1 kV - Part 1: General requirements - Common specifications

11. Conductors

11.1 Scope

11.1.1 Types and Uses

The type and configuration of the phase conductor and earthwire shall be in accordance with the requirement of this specification. For types of conductor reference should be made to **Annex 11-1**.

11.1.2 Definition

The following definitions are used throughout this specification:

ACCC	Aluminium Conductor Composite Core
AAC	All Aluminium Conductor
AAAC	All Aluminium Alloy Conductors
ACSR	Aluminium Conductor Steel Reinforced
ACAR	Aluminium Conductor Alloy Reinforced
AACSR	Aluminium Alloy Conductor Steel Reinforced
ACSR/AW	Aluminium Conductor Aluminium clad steel reinforced
S	Galvanised Steel Conductor
SA	Aluminium clad steel conductor

11.1.3 Sub-conductor Configuration

For details of sub-conductor configuration and spacing reference should be made to **Annex 11-2.**

11.1.4 Optical Fibre Cable

For details of embedded optical fibre cable reference should be made to Section 14 of this specification.

11.1.5 Special Warranty for ACCC Conductor

The Contractor shall submit warranty certificate for ACCC conductor to the Employer within 30 days of the date of sale of the ACCC Conductor. The warranty shall valid for three years and shall start from the date mentioned in Conditions of Contract, Volume 1 of the bidding document. Scope of warranty shall be as below:

The ACCC® Conductor O.E.M. Warranty covers ACCC® Conductor and Connector failure due to:

1. Sag, Thermal Elongation & Creep: This Plan will repair or replace any covered Line that Creeps or Sags more than 5% of its measured and documented installation sag.

2. Wind generated Aeolian Vibration and Galloping: This Plan covers the failure of the covered Line and Connectors, resulting from wind generated Aeolian vibration and galloping.

3. ACCC® Composite Core Failure: This Plan covers ACCC® Conductor against failure of the composite core if it fails while operating within the manufacturers recommended operating range, plus 15%. Operating the covered line in excess of these permissible tolerances will void this warranty.

4. Breakage: This Plan covers line breakage (a) occurring while operating the line within the manufacturer's recommended operating range, plus 15%, and (b) not caused by any excluded causes set forth in the Conditions and Exclusions Section.

5. Corrosion & Rust: This Plan covers the Line failure resulting from corrosion caused by electrolysis, or rust.

6. Unwinding: This Plan covers Line failure resulting from the unwinding of the Line, except for unwinding caused by an excluded item or cause set forth in the Terms & Conditions Form.

11.2 Design

11.2.1 General

All AAC, AAAC, ACSR, AACAR and AACSR conductors shall comply with the requirements of IEC 61089. Where applicable the selection of parameters not quantified nor specified in IEC 61089, reference shall be made to the appropriate standard Specification stated in **Annex 11-1**.

The design of non-standard conductors including thermal resistant, fibre optic earthwire and those incorporating shaped wire sections shall be submitted to the Employer. **This is a Hold Point.**

11.2.2 System Loading Conditions

Reference should be made to **Annex 11-3** for details of the applicable phase conductor and earthwire system loading.

11.3 Materials

11.3.1 Conductors

11.3.1.1. The materials used for construction of ACCC conductor shall be such that the conductor meets the specified technical and performance requirements.

The ACCC conductor shall utilize a light weight, high strength glass and carbon fiber core embedded in a high performance thermoset resin matrix, produced using an advanced pultrusion process. Number of core shall be one. The materials shall be of such proven quality that its properties are not adversely influenced by the normal operating conditions of transmission line in tropical environment conditions.

The hybrid structural core shall be surrounded by helically wound, trapezoidal shaped, high efficiency fully annealed aluminium wires.

11.3.1.2. Aluminium wire used for AAC, ACSR, ACAR, and ACSR/AW or incorporated in fibre optic earthwire shall comply with the requirements of IEC 60889. The aluminium shall be of the highest purity commercially obtainable, the copper content shall not exceed 0.04%.

11.3.1.3. Aluminium alloy wire used for AAAC, AACSR or incorporated in fibre optic earthwire shall comply with the requirements of IEC 60104. The copper content shall not exceed 0.05%. Galvanised steel core wire used for ACSR and AACSR shall comply with the requirements of IEC 60888. Aluminium clad steel wire for ACSR/AW, SA or incorporated in fibre optic earthwire shall comply with the requirements of IEC 61232.

11.3.1.4. Shaped aluminium or aluminium alloy wire sections shall conform to the requirements of the appropriate IEC standard. Galvanised steel earthwire shall comply with the requirements of IEC 60888.

11.3.2 Conductor Grease

All grease applied to the specified inner aluminium, aluminium alloy or steel strands of the conductor shall be of a neutral type and shall have the following properties:

a. The grease shall protect the conductors from corrosion in service which may include operation in atmospheres containing salt spray or industrial pollution;
b. The grease shall not corrode steel, aluminium or aluminium alloy wires or any combination of wires;
c. The grease shall be compatible with any wire drawing lubricant present on the conductor wires.
d. The grease or any component of the grease shall not flow within, nor exude from the conductor during storage, transport, erection or during service at temperatures up to 100°C;
e. The grease shall retain its properties at all operating temperatures specified in **Annex 11-1;**
f. The grease shall not be damaged by storage or by the conductor manufacturing process (hot applied grease shall be unimpaired after heating to 20° C above its dropping point for 150 hours, or 10°C above the temperature reached during the application of the grease to the conductor, whichever is greater);
g. The grease shall have adequate resistance to oxidation;
h. The grease shall not present a health hazard and shall conform to relevant current health and safety requirements.

11.4 Workmanship

11.4.1 All the conductor strands shall be smooth, uniform and free from all imperfections, such as spills and splits, cracks, die marks, scratches, abrasions, rust etc.

11.4.2 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protrusion of wires), wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

11.4.3 Precautions shall be taken during the manufacture, storage and delivery of conductors to prevent contamination by copper or other materials which may adversely affect the aluminium or aluminium alloy.

11.4.4 Where permitted in IEC 61089 for aluminium or aluminium alloy wires, the preferred method of jointing single wires is cold pressure welding.

11.5 Protective Treatment

11.5.1 Necessary protective treatment for ACCC conductor shall be taken on Aluminium strands, composite core and stranded conductor as per relevant IEC, ASTM and BS EN standards.

11.5.2 All steel core wires of the conductors having steel core, unless specified to the contrary, shall be hot-dipped galvanised to comply with the requirements of IEC 60888.

11.5.3 Aluminium clad steel, if used, shall comply with the requirements of IEC 61232.

11.5.4 Unless specified to the contrary conductors having steel core shall be uniformly covered with a neutral grease (i.e. as case 2 appendix C IEC 61089). The minimum fill factor of the grease shall not be less than 70%. Each layer of wire except the outer layer shall have, both lengthwise and peripherally, an even and continuous coating of grease. Wax thickened greases shall be applied at a temperature above the dropping point, and shall be substantially free from contaminants. No grease must be visible on the exterior of the conductor and every effort should be made to minimize the presence of drawing oil on the surface of the finished conductor.

11.6 Conductor Erection

11.6.1 Method Statement

The Contractor shall provide the Engineer with a method statement giving sequential details of the conductor stringing, sagging, jointing, clamping-in etc. methods and including his intended program. Full tension stringing shall be undertaken, unless otherwise agreed in writing by the Engineer.

The method statement shall be submitted to the Employer for acceptance the requisite period before conductor stringing commences. **This is a Hold Point.**

11.6.2 Conductor Lengths and Joints

The fullest possible use shall be made of the maximum conductor lengths in order to reduce to a minimum the number of mid-span joints. The number, span and location of any phase conductor or earthwire mid-span joints used on the line shall be approved by the Employer. There shall not be more than one such joint per conductor in any one span. A conductor schedule detailing the lengths of conductors and positions of mid-span joints in the section, shall be submitted to the Employer for approval; this requisite period before conductor stringing commences. **This is a Hold Point.**

Mid-span joints shall not be used:

a. Within 3m of the conductor suspension clamp or tension joint (dead end).
b. In sections between tension towers of less than three spans unless specifically approved.
c. In spans over railways, navigable rivers, main roads, trunk routes, buildings or spans covered by special wayleave conditions. A line shall be deemed to be over a building when, at the specified maximum conductor temperature with an assumed conductor swing of 45 degrees from the vertical, any part of the building is vertically below any conductor.
d. In any span immediately adjacent to a span as described in (c), unless the tower between such span and adjacent spans is fitted with tension insulator sets.

Joints in Wires

Aluminium Wires

During stranding, no Aluminium wire welds shall be made for the purpose of achieving the required conductor length.

No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However joints are permitted in the inner layer(s) of the conductor unavoidably broken during stranding provided such breaks are not associated with either inherently defective wire or with the use of short lengths of Aluminium/ Alloy wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other Aluminium/Alloy wire of the completed conductor. A record of such joints for each individual length of the conductor shall be maintained by The Contractor for Employer's review.

Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand guaranteed.

11.6.3 Repair Sleeves

In the case of local damage to individual wires of a conductor during erection, repair sleeves may be permitted with the approval of the Employer and subject to no repair sleeve being nearer than 1.2 m from any conductor fitting other than spacer dampers. **This is a Hold Point.**

11.6.4 Line Terminations

Line termination fittings either bimetallic or aluminium shall be fitted as specified at line terminations, to provide the connection interface between the downleads and/or downdroppers and the substation equipment and/or cable sealing ends.

11.6.5 Inelastic Extensions of Conductors

The Contractor shall be responsible for evaluating the inelastic extension which is likely to occur in the conductor over the defined period of years. Reference shall be made to the recommendations contained in CIGRE Electra No. 75 for the evaluation. Compensation for the inelastic extensions so determined shall be made by the selection and use of an optimum pretension and time period and over tensioning the conductor at the time of erection. Over tensioning of the conductor shall be made by an allowance in the erection temperature i.e. sagging temperature equals conductor temperature minus equivalent

temperature correction. However, it should be noted that the maximum conductor tension under the defined system loading must not be exceeded at the time the transmission line is handed over.

The Contractor shall ensure that the erection tensions do not exceed the appropriate system loading on the supports. The Contractor's proposals shall be submitted to the Employer in conjunction with the erection sags and tensions.

11.6.6 Sags and Tensions

11.6.6.1 The Contractor shall prepare sag and tension calculations and schedules for the phase conductor and earthwire for every span at the proposed range of sagging operations, the design loading condition and at the maximum conductor operating temperature.

11.6.6.2 Due allowance shall be made for any severe gradient in the transmission line route, in addition the suspension insulator sets shall be vertical at the specified temperature immediately after stringing.

11.6.6.3 These schedules shall be submitted to the Employer the requisite period prior to the commencement of conductor stringing and for inclusion within the supply and install manual. **This is a Hold Point.**

11.6.7 Conductor Stringing

11.6.7.1. The Contractor shall take special care that during the stringing of the phase conductor and earthwire to ensure that no contact is made with the ground or any obstacles such as walls, fences, or buildings etc., nor shall they be over-strained during this process.

11.6.7.2. Drum battens shall not be removed until conductor drums are properly mounted at the drum station on the line and the battens shall be immediately refitted to the drums if any surplus conductor is left thereon. Drums will be transported and positioned on station with the least possible amount of rolling.

11.6.7.3. Approved means shall be provided to prevent any damage to conductors where they are run over temporary supports.

11.6.7.4. The conductors, joints and clamps shall be erected in such a manner that no bird caging, over- tensioning of individual wires or layers, or other deformation, or damage to the conductors shall occur.

11.6.7.5. Clamps or hauling devices shall, under erection conditions, allow no relative movement of strands or layers of the conductor. If required by the Employer, this property shall be demonstrated by actual tests.

11.6.7.6. The Contractor shall at his own expense make suitable arrangements for temporary guying of supports where necessary. Suitable plates (detachable or otherwise) shall be provided on the supports for the attachment of any temporary guys. The additional loads imposed on specific support during conductor stringing by the use of temporary guys shall be calculated and submitted to the Employer for appraisal prior to conductor stringing commencing. **This is a Hold Point.**

11.6.7.7. Each conductor shall be clamped in at suspension points and the adjacent spans fitted with spacer dampers or vibration dampers at a concurrent operation, after having been sagged and tensioned off at section supports. The maximum time period between clamping-in and fitting of spacer dampers or vibration dampers shall not exceed 36 hours, or such other time agreed with the Engineer.

11.6.7.8. If this period is exceeded the Employer reserves the right to undertake a random inspection of the unclamped and lowered conductor and if necessary the cutting out and replacement of any suspect conductor. All expenses involved in the unclamping, conductor lowering, conductor replacement and re-sagging of the conductor shall be borne by the Contractor, whether or not any damage is found.

11.6.8 Running Out Blocks

11.6.8.1 Conductor running out blocks shall be free running on ball or roller bearings and of an approved design to avoid damage to the conductor. The blocks shall have an electrical conducting path between their suspension fittings and the conductors supported by the blocks.

11.6.8.2 If conductors are being erected on one circuit of a double circuit line with the other circuit live or in other situations likely to induce a voltage into the conductor all running-out blocks shall be bonded to the support steelwork by means of flexible connections approved by the Employer.

11.6.8.3 The diameter of the running out block shall not be less than 20 times the diameter of the respective conductor. Alternatively, where a group of smaller blocks are used these shall be arranged such that the conductor passes over an equivalent radius of not less than 20 times the conductor diameter.

11.6.8.4 The hangers for the running out blocks should be of a uniform length so that the conductors and the sheaves are held at a uniform distance, not exceeding 500 mm above, or below their final position when clamped in.

11.6.9 Sagging

The Contractor shall use approved dynamometers, accurate sighting and/or other apparatus necessary for the proper checking of the work. Every section shall be offered to the Employer for inspection of the results before sagging equipment, dynamometers, sighting or other apparatus is removed from that portion of the Works. **This is a Notification Point.**

The assumed temperature of the conductor for the purposes of sagging, will be determined from an accurate thermometer basket suspended clear of the support steelwork at a point adjacent to the bottom crossarm level of one support at one end of the span being used to control sagging. The basket shall have been in position 15min before temperature reading is taken.

11.6.10 Earthing of Conductor During Erection (Safety)

During the erection of conductors and subsequently when any work is being carried out on the support above the anti-climbing device level, the Contractor shall ensure the conductors are adequately earthed at points not more than three spans apart, or such other spacing as may be necessary or directed by the Employer.

The earthing equipment shall be approved by the Employer and shall be designed to be clearly visible from the ground.

11.6.11 Crossings Over Roads, Railways, Buildings, Structures, etc.

Where the transmission line crosses over roads or tracks liable to be used by traffic of any description, or railways, buildings, structures and obstacles of any kind the Contractor shall provide temporary scaffolding during stringing operations. Scaffolding in accordance with this Clause and Clause 5.5.3 shall be of adequate construction and height. Drawings and supporting calculations shall be submitted to the Employer and governmental or statutory bodies. **This is a Hold Point.**

11.6.12 Live Line Scaffolds

Where it is possible only to have a restricted outage on a distribution or a transmission line sufficient only to erect the upper portion and 'net' the scaffold a live-line scaffold shall be used. Live line scaffolds shall be in accordance with the requirements of Clause 5.5.5. Drawings and supporting calculations shall be submitted to the Employer and governmental or other statutory bodies. **This is a Hold Point.**

11.6.13 Downleads

Downlead spans between terminal supports and substation anchor points shall be erected at reduced tensions in accordance with provision mentioned in Tower Section. Downleads shall be considered as slack span.

The Contractor shall include within his method statement details of his proposal for tensioning downleads.

11.6.14 Conductor Cutting

Conductor joints shall be made over protective sheeting and waste materials shall be removed from site. Cutting of layers of conductors shall be carried out with tools designed to prevent damage to underlying strands. Preparation prior to jointing shall be carried out in accordance with Clause 11.6.15.

11.6.15 Jointing

11.6.15.1. Before the conductor is inserted into compression type joints, clamps, connectors, compression spacers or repair sleeves, it shall be prepared in the following manner, using an approved grease for phase conductors and earthwires.

11.6.15.2. The Contractor shall include within his Method Statement full details of his proposed jointing procedures, including where necessary appropriate diagrams.

a. **New Conductor**: The outer layer of the conductor throughout the whole length of the joint shall be wiped clean, coated with grease, wire brushed (stainless steel) through the grease which shall be left on and assembled in the fitting after a further libreal application of grease.

b. **Old Conductor**: Where a compression joint is to be made on to old conductor the Employer shall be given the requisite period of notice. **This is a Notification Point.**

11.6.15.3. Unless otherwise agreed with the Employer who will take account of the degree of corrosion of the conductor, all the aluminium layers, after preliminary cleaning of the individual aluminium wires with a fine grade of abrasive paper or cloth, shall be coated with grease, wire brushed through the grease which shall be left on and assembled in the fitting after a further libreal application of grease. The innermost layer of aluminium wires should not be unlaid but treated on their external surfaces only.

Care shall be taken to avoid damage to the wires especially by kinking or excessive removal of metal. If however, damage does occur the whole conductor shall be cut clear of the damage and as a fresh joint prepared.

11.6.15.4. All compression joints shall be fitted strictly in accordance with the manufacturer's instructions. During compression all dies shall fully close at each end of the bite and the bites shall overlap by a minimum of 5 mm. All flashes shall be removed.

11.6.16 Surface Greasing of Conductor

Except where specified to the contrary, the conductor shall be coated with an approved grease at the point of attachment of fittings immediately before the final assembly of any fittings and all surplus grease shall be removed after assembly.

11.6.17 Greasing of Bolted Interfaces

11.6.17.1. For bolted jumper connections, non-tension joints, tee connectors and bonding leads, the lug and clevis contact faces shall be greased with an approved grease, wire brushed through the grease libreally before assembly. All nuts and bolts shall be tightened to the supplier's recommended torque.

11.6.17.2. Where jumper or non-tension joint bolts are found to be loose the Contractor shall dismantle and re- assemble the joint as above before re-bolting and tightening.

11.6.17.3. All bolts shall face towards the centre line of each conductor bundle.

11.6.18 Inspection Holes

Where a tension joint is supplied with an inspection hole the aluminium alloy drive screw shall be hammered in firmly until smooth and flush with the surface of the aluminium sleeve using the flat face of a hammer. Final smoothing over may be carried out using a flat file if necessary.

11.6.19 Tension Support Jumpers

11.6.19.1. All tension support jumper loops shall be erected complete with all fittings in accordance with the approved wire clearance diagram.

11.6.19.2. Where quadruple bundle sub conductors are specified a reduced spacing twin spacer shall be fitted on the lowest pair of the jumper sub-conductors. They shall be adjusted on site to give the best possible clearance to prevent contact between the phase and jumper sub-conductors.

11.6.19.3. Where specified bonding spacers shall be located at a point suitable for the application of temporary earthing bonds, normally near the middle of the jumper. In the case of non-tension joint bonding spacers the conductors must butt in the centre. Jointing shall be in accordance with the requirements of Clause 11.6.15 and resistance measurement in accordance with Clause 11.7.14.

11.6.19.4. Where tubular jumpers are fitted, the earthing bar shall be arranged as near as practical to a step-bolt of the support.

11.6.20 Spacer Dampers

Spacer dampers where specified shall be fitted to the phase conductors strictly in accordance with the manufacturer's instructions.

Where there is a mid-span joint or repair sleeve on a conductor, the adjacent spacer damper must not be closer than 2m, or further away than 12m from the mid-span joint or repair sleeve. If possible, this should be achieved using the correct configuration of spacer damper positions. This configuration can be used in reverse by taking the measurement from the other support. Where the configuration given does not allow a spacer damper to be in the correct juxtaposition with the mid-span joint or repair sleeve an additional spacer damper should be fitted.

11.6.21 Vibration Dampers

Vibration dampers shall be fitted to the earthwires and where specified the phase conductors, strictly in accordance with the manufacturer's instructions.

11.6.22 Aircraft Warning Spheres

Where specified aircraft warning spheres shall be fitted to the earthwires, complete with factory formed helical armour rods. The spheres shall, be located in accordance with the requirements of ICAO Annex 14 unless specified to the contrary.

11.6.23 Earthwire Bonds

Flexible earthwire bonds in accordance with the requirements of clause 10.2.20 shall be fitted between all earthwire suspension and tension sets and the support. Where OPGW is used the connection to the earthwire shall if necessary be via a 'C' type connector (ref. clause 10.2.19).

No bond is required at terminal support positions where the earthwire jumper shall be attached directly to the support. At other tension positions the earthwire shall be continuously jumpered through. Where OPGW is used the jumper shall be formed from a short length of equivalent conductor attached to the earthwire via a 'C' type connector.

11.7 Quality Control

11.7.1 Conductors

11.7.1.1 Sample tests shall be undertaken on all conductors in accordance with the requirements of IEC 61089 as applicable and this specification. **This is a Notification Point.**

11.7.1.2 The mechanical tests shall be taken on straightened samples of individual wires taken after conductor stranding. In the event of the sample from any length not passing the mechanical or resistance tests, a second and third sample shall be taken from the same length, and if one of these also fails under test, the length of conductor (i.e. drum) from which it has been taken shall be rejected. For the ductility tests, should any variation occur in the results between the torsion and elongation methods of testing the results of the torsion test shall prevail.

11.7.1.3 In the event of any machinery used for conductor manufacture being used for materials, other than aluminium, galvanized or aluminium clad steel, the manufacturers shall furnish the Employer

with a certificate stating that the machinery has been thoroughly cleaned before use on aluminium, aluminium alloy, galvanized or aluminium clad steel wire and that the conductor is free from contamination.

11.7.2 Grease

11.7.2.1. The manufacturer's type test proposals for proving compliance with this specification with regard to the following grease properties shall be submitted to the Employer. **This is a Hold Point.**

a. dropping point tests;
b. thermal history test;
c. reversibility;
d. oxidation;
e. corrosive substances in grease;
f. anti-corrosion properties;
g. complete conductor test, to ensure that the grease does not appear through the outer wires at less than the specified temperature.

11.7.2.2. Sample tests on grease shall be undertaken at the same time as sample tests on the conductor. The mass and length of the conductor sample shall be measured and recorded. The sample shall be inspected to ascertain that no grease is visible on the exterior. The wires shall then be separated progressively layer by layer whilst being inspected to verify the coating requirements are met.

11.7.2.3. Grease for the dropping test shall be removed without heating, the remaining grease may then be removed by a convenient method. The mass of the cleaned conductor sample shall be determined and recorded. The mass of grease shall be determined from the difference in masses and shall be recorded.

11.7.2.4. The mass of grease per unit length of conductor shall not be less than the minimum value given in **Annex 11-1**.

11.7.2.5. All drums of conductor shall be routinely inspected for traces of visible grease on the exterior of the conductor.

11.7.3 Galvanizing

Tests for galvanized steel wire shall be carried out at the works to ensure compliance with the requirements of IEC 60888. Details of the test results shall be made available to the Employer upon request.

11.7.4 Aluminium Clad Steel

Tests for aluminium clad steel wire shall be carried out at the works to ensure compliance with the requirements of IEC 61232. Details of the test results shall be made available to the Employer upon request.

11.7.5 Type Tests

The following tests shall be conducted once on sample/samples of conductor from each manufacturing facility:

(a) ACCC Conductor

(1)	**On complete Conductor**	
i)	DC resistance test on stranded conductor	: As per Annex 11.4
ii)	UTS test on stranded conductor	: As per Annex 11.4
iii)	Stress- Strain test on stranded conductor and core at room temperature	: IEC 61089
iv)	Sheaves Test	: As per Annex 11.4
v)	Axial Impact Test	: As per Annex 11.4
vi)	Radial Crush Test	: As per Annex 11.4
vii)	Torsional Ductility Test	: As per Annex 11.4
viii)	Aeolian Vibration Test	: As per Annex 11.4
(2)	**On Conductor Strand/core**	: As per Annex 11.4
i)		: As per Annex 11.4
ii)	Coefficient of linear expansion on composite core	: As per Annex 11.4
iii)	Bending test on composite core	: As per ASTM B987
iv)	Brittle Fracture Test	: As per Annex 11.4
Type tests specified shall require to be submitted in the bid for the ACCC Conductor. Report shall be considered valid if the tests conducted within the past 5 years as on the date of bid opening at an accredited ISO/IEC 17025 third party laboratory or at manufacturer's own laboratory witnessed by the representative(s) of a utility or witnessed by a representative of an ISO/IEC 17025 accredited laboratory. In the case of composite core conductors, the tests specified shall be carried out before stranding on as-manufactured samples.		
The ACCC conductor, to be used in the transmission line, must be type tested. If the bidder does not submit above satisfactory type test reports for the offered type ACCC conductor with their bid, then the type tests as per above requirements must be conducted during contract execution stage in presence of Employer Engineers within the Contract price.		

(a) ACSR Conductor

The following tests shall be conducted once on a sample of conductor for each type of conductor for manufacturing facility:

i)	DC resistance test on stranded conductor	: As per Annex 11.4a
ii)	UTS test on stranded conductor	: As per Annex 11.4a

11.7.6 Acceptance Tests

(a) ACCC Conductor		
i)	Visual and dimensional check on drum	: As per Annex 11.4
ii)	Visual check for joints scratches etc. and length measurement of conductor by rewinding	: As per Annex 11.4
iii)	Dimensional check on core/core strands and Aluminium or Aluminium Alloy strands	: As per Annex 11.4
iv)	Check for lay-ratios of various layers	: As per Annex 11.4
v)	Breaking load test on core/core strands and aluminium/Aluminium alloy strands	: As per Annex 11.4
vi)	Minimum conductivity test on Aluminium/thermal resistant Aluminium Alloy strands	: As per IEC 60889
vii)	Procedure qualification test on welded joint of Aluminium/ Aluminium Alloy strands	: As per Annex 11.4
viii)	Heat resistant test on Aluminium Alloy strands	: As per Annex 11.4
ix)	Glass transition temperature test for composite core	: As per Annex 11.4
x)	Galvanic layer thickness test for composite core	: As per Annex 11.4
xi)	DC resistance test on aluminium/Aluminium alloy strands	: As per Annex 11.4
xii)	Bending test on composite core	: As per Annex 11.4
All the tests to be performed on composite core shall be carried out in as manufactured conditions before dispatch of composite core. Sample tests of Composite Core shall be done on 5% reels of each lot/shipment. All acceptance tests of Conductor as mentioned above to be carried out on 10 % of conductor drums.		

(b) ACSR Conductor/Galvanized Steel Earthwire		
i)	Visual and dimensional check on drum	: As per Annex 11.4a
ii)	Visual check for joints scratches etc. and length measurement of conductor by rewinding	: As per Annex 11.4a
iii)	Cross Sectional Area of Complete Conductor	: IEC 61089
iv)	Overall Diameter of Conductor	: IEC 61089
v)	Surface Condition of the Conductor	: IEC 61089

vi)	Check for lay-ratios of various layers	: As per Annex 11.4a
vii)	Mass Per Unit Length/Linear Density	: IEC 61089
viii)	Dimensional check on steel and aluminium/ Aluminium alloy strands	: As per Annex 11.4a
ix)	Breaking load test on steel and aluminium/Aluminium alloy strands	: As per Annex 11.4a
x)	Wrap test on steel and aluminium/Aluminium alloy strands	: IEC 60888 and IEC 60889
xi)	DC resistance test on aluminium/Aluminium alloy strands	: IEC 60889
xii)	Stress at 1% Extension Test of Steel wire/strands	: IEC 60888
xiii)	Galvanic layer thickness test for steel strands	: As per Annex 11.4a
xiv)	Torsion and Elongation tests on steel strands	: As per Annex 11.4a
xv)	Procedure qualification test on welded joint of Aluminium/ Aluminium Alloy strands	: As per Annex 11.4a
xvi)	Barrel batten strength test	: As per Annex 11.4a
xvii)	Mass of Grease	IEC 50182
xviii)	Drop point of grease	ASTM D 566/IEC 50182&IEC61089
xix)	Verification of conductor length	The Employer reserves the right to verity the length of conductor after unreeling at least Five percent (5%) to ten percent (10%) of the drums in a lot offered for inspection. The actual quantity will be discussed and mutually agreed to by the Supplier & Employer in the Quality Assurance
All acceptance tests of Conductor as mentioned above to be carried out on 10 % of conductor drums. Sampling plan for Mass of grease and drop point of grease shall be as per IEC 50182.		

(c) Aluminium Clad Steel Earthwire		
i)	Visual and dimensional check on drum	: As per Annex 11.4a
ii)	Visual check for joints scratches etc. and length measurement of conductor by rewinding	: As per Annex 11.4a

iii)	Cross Sectional Area of Complete Earthwire	: IEC 61089
iv)	Overall Diameter of Earthwire	: IEC 61089
v)	Surface Condition of the Earthwire	: IEC 61089
vi)	Check for lay-ratios of various layers	: As per Annex 11.4a
vii)	Mass Per Unit Length/Linear Density	: IEC 61089
viii)	Tensile Test on ACS Wire/strand	: IEC 61232
ix)	Elongation tests on ACS Wire/strand	: IEC 61232
x)	Torsion test on ACS Wire/strand	: IEC 61232
xii)	Thickness of aluminium on ACS Wire/strand	: IEC 61232
xiii)	Resistivity test on ACS Wire/strand	: IEC 61232
xiv)	Stress at 1 % extension on ACS Wire/strand	: IEC 61232
xv)	Mass of Grease	
xvi)	Drop point of grease	ASTM D 566
xvii)	Verification of conductor length	The Employer reserves the right to verity the length of conductor after unreeling at least Five percent (5%) to ten percent (10%) of the drums in a lot offered for inspection. The actual quantity will be discussed and mutually agreed to by the Supplier & Employer in the Quality Assurance
All acceptance tests of Conductor as mentioned above to be carried out on 10 % of conductor drums. Sampling plan for Mass of grease and drop point of grease shall be as per IEC 50182.		

11.7.7 Routine Test

a)	Check to ensure that the joints are as per Specification
b)	Check that there are no cuts, fins etc., on the strands.
c)	Check that drums are as per Specification
d)	All acceptance tests as mentioned above to be carried out on 10 % of drums

11.7.8 Tests During Manufacture

a)	Chemical analysis of Aluminium /Aluminium alloy used for making Aluminium Alloy / Aluminium strands	: As per Annex 11.4
b)	Chemical analysis of core strands/composite core	: As per Annex 11.4

Costs of all tests, as required, shall be deemed to be included in the contract price.

11.7.9 Test Certificate

All metallic materials used in the manufacture of conductors shall be covered by test certificates stating their mechanical and chemical properties to prove compliance with this specification and IEC as appropriate. These certificates shall be made available to the Employer upon request.

Test records covering type and sample tests shall be made available to the Employer.

11.7.10 Certificate of Conformity

Whenrequestedcopiesofthefollowingcertificate/recordsshallalsobeforwarded:

a. metallic material test certificate;
b. conductor stranding equipment non contamination certificate;
c. galvanizing test records;
d. ingot zinc certificate;
e. aluminium cladding test records.

11.7.11 Sagging Tolerance

Immediately after the conductors have been sagged and clamped in, the mean sag of the conductors forming any phase shall not differ from the calculated erection sag by more than 4% and the sub-conductors forming each phase conductor bundle shall not differ from each other by more than 40 mm. In addition the sag of any one phase shall not differ by more than 150 mm from the mean sag of all phases in the same span. The linear adjustment available on the sag adjusters, unless specified to the contrary, at the end of the maintenance period shall not be less than ±75 mm.

11.7.12 Manufacturing Tolerance

a) ACSR

Manufacturing tolerances on the dimensions to the extent of ± 0.5% percent shall be permitted for individual strands and the complete conductor.

b) ACCC

For Composite core as per ASTM B987, section 12 (Dimensions and Permissible Variation), the average diameter shall not differ by more than +/- 0.05 mm from the nominal diameter of the composite core.

For Conductor as per ASTM B857, section 13 (Variation in area and diameter) The area of cross section of the aluminum wires of a conductor shall be not less than 98 % nor more than 102 % of the area specified and The diameter of the finished conductor shall be not less than 99 % nor more than 101 % of the diameter specified.

11.7.13 Jointing Competence

Tension and non-tension compression joints, repair sleeves, tee connectors and bimetallic connectors shall be fitted to the conductors only by linesmen whom the Contractor possess written approval of their Jointing Competence issued by the Employer. Where necessary the Contractor shall arrange for the appropriate tests to be witnessed by the Employer allowing the requisite period of notice. **This is a Hold Point.**

11.7.14 Electrical Resistance of Joints and Clamps

The maximum resistance, measured overall (primary measurement), of all joints shall not exceed 75% of the resistance of an equivalent length of conductor.

11.7.15 Bolt Tightness

The Contractor shall be responsible for checking that the bolts in all fittings including spacers, spacer dampers, vibration dampers etc., have been correctly tightened to the Supplier's recommended torque value. A record of this work shall be kept and made available to the Engineer upon request.

11.7.16 Clearances

Clearance between phase conductors, including jumpers and ground and between jumpers and support structures shall be checked during erection and before handing over the line.

11.7.17 Final Inspection

Immediately prior to hand over of the transmission line, the Contractor shall conduct a final line route inspection to ensure that the specified clearances are available to all supports, ground etc. all temporary earthings have been removed and that extraneous objects are removed. **This is a Notification Point.**

Where specified after the final route inspection the Contractor shall demonstrate by means of a low voltage test, to the complete satisfaction of the Employer, that there is complete continuity over each phase. **This is a Hold Point.**

11.7.18 Records

During the course of the work, the SIMM document (reference Clause 4.7) shall be updated with details of the actual phase conductor and earthwire erection sags, location of phase conductor and earthwire tension joints including repair sleeves and the electrical resistance of all joints and clamps including the name of the linesman responsible and the date of assembly.

Annex 11-1: Conductor - Types and Uses

Annex 11-1(5): 132kV(Overland Portion)

Conductor	Phase	Earthwires	OPGW
Designation (Code Name)	Grosbeak	7x3.25 GS Earthwire	OPGW 7x3.25 GS equiv.
Type	ACSR		"A"
Reference standards	ASTM B232		IEC 61089
Aluminium Alloy Grade Steel Grade	- -		as appropriate
Galvanising Thickness	-		-
Aluminium class (AS wire)	Ref IEC 61232		-
Aluminium type (AS wire)	-		20 % IACS
Conductor operating temperature range (°C)	5-80		-
Minimum mass of grease (kg/km)	As per technical specification		-
Creep period of conductor to be considered (years)	20		-
Number and diameter of wire (no./mm)	A1. 26/3.973 St. 7/3.089		-
Overall diameter (mm)	25.16	9.75	-
Nominal breaking load (kN)	112		-
Weight (kg/km)	-		-
Direction of external lay	Right hand		Right hand

Annex11-1(7): 132kV – Overland Portion (ACCC Grosbeak)

Conductor	Phase
Designation (Code Name)	ACCC Grosbeak (ACSR Grosbeak equiv. diameter)
Type	ACCC
Reference standards	ASTM/IEC/BSEN
Aluminium/Aluminium alloy grade	1350 O
Steel grade	-
Galvanising Thickness	-
Aluminium class (AS wire)	-
Aluminium type (AS wire)	-
Conductor max. continuous operating temperature (°C)	180
Minimum mass of grease (kg/km)	-
Creep period of conductor to be considered (years)	-
No. and diameter of aluminium wire (No./mm)	Refer Note (i)
No. and diameter of steel wire (No./mm)	-
Overall diameter of conductor (mm)	25.16 (max.)
Overall sectional area of conductor (mm^2)	-
Rated tensile strength of conductor (kN)	112
Weight (kg/km)	1280 (max.)
Direction of external lay	Right hand
Cross Sectional Area of Al (mm^2)	
Cross Sectional Area of Composite Core (mm^2)	
No. of Composite Core (mm)	1
Shape of wires	All trapezoidal
Diameter of Composite Core (mm)	
Rated tensile strength of core (kN)	
Current carrying capacity at 120 Deg C (amp)	1220 Min.
Current carrying capacity at 180 Deg C (amp)	
Max. allowable emergency operating temp.(Deg C)	200
Maximum DC Resistance at 20 Deg C (ohm/km)	0.068
Co-efficient of linear expansion (per Deg C)	

Note:
(i) Number and diameter of the aluminium strands will depend on the conductor manufacturer. The manufacturer must show the aluminum cross-section meets the nominal cross-sectional area shown.
(ii) 40degC ambient, 0.61m/sec wind, 1033 W/sq.m sun
(iv) Absorptivity 0.9 and Emissivity 0.7

Annex 11-2: Sub-conductor Configuration

Configuration	Spacing (mm x mm)	Orientation	Notes
Single	-	-	132kV
Twin	450	Horizontal	230 kV
Quad	450 x 450	Square	400 kV

Annex 11-3: Portion Conductor System Loading

Annex 11-3(5): Conductor System Loading - 132kV [Overland Portion]

Conductor	Unit	Phase	Earthwire OPGW	
Code Name		ACSR Grosbeak	GS 7x32.5 equiv. OPGW	GS 7x32.5
Maximum Working Tension Conditions (MWT)				
Maximum allowable tension	kN	as per Section 8. Tower		
Wind pressure	N/m²	as per Section 8. Tower		
Temperature	°C	5	5	5
Every-day conditions (still air):				
Maximum tension	kN	as per Section 8. Tower		
Temperature	°C	as per Section 2. Technical Particulars		
Erection Conditions (still air)				
Max. tangential tension	kN	n.a.	n.a.	n.a.
Temperature	°C			
Sagging limits of earthwire:				
Sagging limits of earthwire as a percentage of conductor sag	%	n.a.	Max 90	Max 90
Conductor temperature	°C	80	50	50

Notes:

1. OPGW to be sag matched to earthwire.

Annex 11-4: Test Procedures of Conductor

Annex 11-4(1): Tests on ACCC Conductor

1.1 UTS Test on Stranded Conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length between fixing arrangement suitably fixed by appropriate fittings on a tensile testing machine. The load shall be increased at a steady rate up to 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to minimum UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.2 Corona Extinction Voltage Test (Not applicable)

The sample of the conductor of 5 m length shall be strung at a height not exceeding 7.01 m above ground. The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 154kV (rms) line to ground under dry condition. There shall be no evidence of corona on any part of the samples. The test should be conducted without corona control rings. However, small corona control rings may be used to prevent corona in the end fittings. The voltage should be corrected for standard atmospheric conditions.

1.3 Radio Interference Voltage Test (Not applicable)

Under the conditions as specified under (1.2) above, the conductor samples shall have radio interference voltage level below 1000 microvolts at one MHz when subjected to 50 Hz AC voltage of 154 kV line to ground under dry conditions. This test may be carried out with corona control rings and arcing horns.

1.4 D.C. Resistance Test on Stranded Conductor

On a conductor sample of minimum 5m length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero metre and subsequently one metre apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20^0C as per relevant IEC/BS/equivalent standard. The resistance corrected at 20^0C shall conform to the requirements indicated in the STP.

1.5 High Temperature endurance & creep test

Two conductor samples of length equal to at least 100 X d + 2 X a (where, d is the conductor diameter and a is the distance between the end fitting and the gauge length) shall be strung at tension equal to 25 % of conductor UTS. The distance, a, shall be at least 25 % of the gauge length or 2 m whichever is the smaller. The conductor samples shall be subjected to tests as indicated below:

(i) On one of the conductor samples, the conductor temperature shall be maintained at 20 deg C for 1000 hours. The elongation/creep strain of the conductor during this period shall be measured and recorded at end of 1 hour, 10 hour, 100 hour and subsequently every 100 hour upto 1000 hours time period.

(ii) On other conductor sample, the conductor temperature shall be increased to designed maximum temperature in steps of 20 deg. C and thermal elongation of the conductor sample shall be measured &

recorded at each step. The temperature shall be held at each step for sufficient duration for stablisation of temperature. Further, the temperature of the conductor shall be maintained at maximum continuous operating temperature (±10 Deg. C) for 1000 hours. The elongation/creep strain of the conductor during this period shall be measured and recorded at end of 1 hour, 10 hour, 100 hour and subsequently every 100 hour upto 1000 hours time period.

The supplier shall furnish details of creep characteristic in respect of the conducted based on laboratory test and other laboratory investigations/ experimental conducted on similar type of conductor and shall indicate creep strain values corresponding to 1 month, 6 month, 1 year, 10 year & 20 year creep at everyday tension & continuous designed temperature as well as room temperature.

1.6 Sheaves Test

The conductor sample of minimum length of 35 meter shall be tested in accordance with IEC 60794-1-2, Section 20, Figure 27 (Procedure 4) with the following details: Tension shall be 10% of the conductor UTS; pulley diameter shall be at least 35 times that of the conductor; angle between the pulleys shall be of 20 degrees. . The conductor shall be passed over the pulleys a minimum of 18 times at a speed of 0.2 to 0.5 m/sec. After this test, UTS test of the conductor shall be performed and evaluated. In the case of polymer composite core conductor, the core shall be inspected for any sign of damage or cracking by subjecting the core to a dye penetration test as per ASTM section 14. Dye penetrant exposure time shall be 30+1/-0 minutes.

1.7 Axial Impact Test

The conductor sample shall be suspended vertically and load applied by dropping a 650 Kg from an elevation of 4 meters above the sample. The impact velocity shall be not be less than 8 m/sec. with an initial pre-tension of 200 kgs. The curve for load vs time shall be recorded and recorded load of failure for core shall not be less than UTS of core.

1.8 Radial Crush Test

A section of conductor is to be crushed between two six inch steel platens. Load shall be held at 350 Kgs for 1 minute and then released. All the Core strands/Core shall be subsequently disassembled and tensile tested. All the Core strands/ Core shall exhibit full strength retention vis-à-vis guaranteed braking strength of core wires (after stranding).

1.9 Torsional Ductility Test

The conductor sample of 10-15 m shall be loaded to 20% of UTS and then rotated in increasing steps of +/- 180 deg. In case of INVAR type HTLS conductor, the entire conductor shall withstand at least 16 such rotation and there shall not be any damage to Aluminium Alloy or INVAR core wires.

In case of carbon-fibre composite core conductors, the conductor sample should be loaded to 10% of UTS and then rotated in increasing steps of +/- 180 deg. The sample length should be a minimum of 1500 times the composite core diameter and the test should be limited to four +/- 180 deg rotations. The twist rate must be specified to be a max. of 1 rotation per minute.

1.10 Aeolian Vibration Test

The conductor and supporting hardware shall be loaded to 25% of RTS. A dynamometer, load cell, calibrated

beam or other device shall be used to measure the conductor tension. Some means should be provided to maintain constant tension to allow for temperature fluctuations during the testing. The overall span between system terminations shall be a minimum of 30 m. The span shall be supported at a height such that the static sag angle of the cable to horizontal is (1.5 ± 0.5) deg in the active span. Means shall be provided for measuring and monitoring the mid-loop (antinode) vibration amplitude at a free loop, not a support loop. An electronically controlled shaker shall be used to excite the conductor in the vertical plane. The shaker armature shall be securely fastened to the conductor so it is perpendicular to the conductor in the vertical plane. The shaker should be located in the span to allow for a minimum of six vibration loops between the suspension assembly and the shaker. The test shall be carried out at one or more resonance frequencies (more than 10 Hz) . The amplitude at the antinode point shall be one third of conductor diameter. The assembly shall be vibrated for not less than 10 million cycles without any failure. After the test, the conductor should not exhibit any damage (broken strands). The conductor shall be tested to demonstrate that it retains at least 95% RTS.

1.11 Temperature Cycle Test

The purpose of this test is verification of degradation characteristics of metallic and non-metallic material when subjected to thermal cycling temperature cycling can create large internal stresses due to thermal expansion mismatch between constituents.

Test Methods:

- Mechanical tension, 20 % RBS, marks on the conductor at the edge of the conductor
- 100 cycles from room temperature up to maximum temperature (180°C). Hold at maximum temperature ± 2.5 deg. C (duration of a cycle, 1 hour or so, non included cooling)
- Mechanical tension up to 70 % RBS at room temperature during 24 H and release to 20 % RBS.
- This cycling test shall be repeated 5 times.
- During the test, temperature of connectors, conductor and resistance are recorded according to ANSI C 119.
- A breaking load test is applied at the end of the test. Conductor strength has to be higher than 95 % RBS.

1.12 Heat Resistance test on Aluminium Alloy wire

Breaking load test as per clause 1.21 above shall be carried out before and after heating the sample in uniform heat furnace at following temperature for seventy two hours. The breaking strength of the wire after heating shall not be less than the 90% of the breaking strength before heating:

Maximum continuous operating temperature of the conductor	Test temperature
Upto 150 deg. C	230 deg. C (+5/-3 deg. C)
More than 150 deg. C & upto 210 deg. C	280 deg. C (+5/-3 deg. C)
More than 210 deg. C & upto 230 deg. C	400 deg. C (+5/-3 deg. C)

1.13 Bending test on aluminium clad core (if applicable)

A sample of aluminium clad invar strand measuring 30 cm in length shall be subject to bending with help of a

vise. The vised length of wire should be 5 cm and radius of bend 4.8 mm. The bending should be first 90 degrees left and 90 degree right. After this operation the strand should cut at the bending point. There should be no separation of core and aluminium at the bending point after this operation.

1.14 Compression test on aluminium clad wires (if applicable)

A sample of aluminium clad core strand 10 mm in length is to be compressed by a plate with a load of 3600 kgs. The aluminium and core strand should not break.

1.15 Coefficient of linear expansion for composite core/ core wires

The temperature and elongation on a sample shall be continuously measured and recorded at interval of approximately 15 degree C from ambient temperature of lab (generally 20degree C) to maximum continuous operating temperature by changing the temperature by suitable means. Coefficient of linear expansion shall be determined from the measured results.

1.16 Strand Brittle fracture test (for polymer composite core only)

The sample shall be tensioned to approx. 25 % of UTS with simultaneous application of 1N-HNO3 acid directly in contact with naked polymer composite core for 96 hrs. The contact length of acid shall not be less than 40mm and thickness around the core not less than 10mm.The rod shall withstand UTS test after 96 hours.

1.17 Visual and Dimensional Check on Drums

The drums shall be visually and dimensionally checked to ensure that they conform to the approved drawings.

1.18 Visual Check for Joints, Scratches etc.

Conductor drums shall be rewound in the presence of the Employer. The Employer shall visually check for scratches, joints etc. and that the conductor generally conform to the requirements of this Specification. Ten percent (10%) drums from each lot shall be rewound in the presence of the Employer's representative.

1.19 Dimensional Check on Core Wires and Aluminium/ Aluminium Alloy Wires

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

1.20 Check for Lay-ratios of Various Layers

The lay-ratios of various layers shall be checked to ensure that they conform to the guaranteed values furnished by the Contractor.

1.21 Galvanising Test

The test procedure shall be as specified in IEC: 888. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

1.22 Aluminum thickness on aluminum clad wires (if applicable)

The thickness of aluminium of the specimen shall be determined by using suitable electrical indicating instruments operating on the permeameter principle, or direct measurement. Measurements shall be read to three decimal places, and number rounded to two decimal places is considered as measured thickness. For reference purposes, direct measurement shall be used to determine aluminium thickness on specimens taken from the end of the coils.

1.23 Torsion and Elongation Tests on Composite Core/ INVAR Core wires

For INVAR type HTLS conductor, the test procedures shall be as per clause No. 10.3 of IEC 888. In torsion test, the number of complete twists before fracture shall not be less than the value specified in the GTP on a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than the value specified in the GTP for a gauge length of 250 mm.

In case of composite core HTLS conductor, the following procedure shall be applicable:

i) **Elongation Test**:-The elongation of the composite core sample at shall be determined using extensometer. The load along the core shall be gradually increased. The elongation achieved on reaching the tensile strength of the core shall not be less than the value guaranteed in the GTP.

ii) **Torsion Test** : The purpose of the test is to determine the resilience of the composite core to twisting and to show that after the composite core has experienced the prescribed twisting, it will not crack or have a loss in tensile strength due to the twisting. ASTM B987 Table 2, a sample shall be cut long enough as to have a gauge length that is 170 times the diameter of the composite core being tested, between the gripping fixtures. For Extra High Strength Grade composite core as per ASTM B987 Table 2, a sample shall be cut long enough as to have a gauge length that is 340 times the diameter of the composite core being tested, between the gripping fixtures. One grip shall then be fixed so that it does not twist and the other end shall be twisted a full 360 degrees and then fixed in this position for 2 minutes. Once the twist time is completed, the core is untwisted an inspected for any crazing or other damage. If no damage is observed, the composite core is then tensile tested to failure and the final load recorded. For the test to be accepted, the composite core must withstand at least 100% of its rated tensile strength. Two samples need to be completed in order to satisfy the testing requirement.

1.24 Breaking load test on Aluminium/ Aluminium Alloy & Composite core/ INVAR Core wires and D.C Resistance test on Aluminium/ Aluminium Alloy wire

The above tests shall be carried out as per IEC: 888/889 or relevant international standards and the results shall meet the requirements of the specification. Breaking Load test on composite core shall be carried out as per ASTM B987 and the results shall meet the requirements of specification.

1.25 Wrap test on Core wires (Applicable for steel/Al clad Steel/invar core only)

The wrap test on core strands shall be meet the requirements of IEC: 888. In case of aluminium clad core wire, the same shall be wraped around a mandel of diameter of five times that of the strand to form a helix of eight turns. The strand shall be unwrapped. No breakage of strand shall occurred.

1.26 Minimum conductivity test on thermal resistant aluminium alloy wire

Resistivity test as per IEC-468/IEC 889 shall be conducted to confirm minimum conductivity as per specification requirement.

1.27 Procedure Qualification test on welded Aluminium/ Aluminium Alloy wire.

Two Aluminium/ Aluminium Alloy wire shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the guaranteed breaking strength of individual strands.

1.28 Ageing Test on Filler (if applicable)

The test shall be done in accordance with Grease drop point test method. The specimen should be drop as a droplet when kept at a temperature 40 deg. C above designed maximum operating temperature of the conductor for 30 minutes. The temperature shall then be increase till one droplet drops and the temperature recorded.

1.29Aluminium conductivity test on aluminium clad wire (if applicable)

Resistivity test as per IEC-468 shall be conducted to confirm minimum conductivity as per specification requirement.

1.30 Glass Transition Temperature Test (for polymer composite core only)

Tg shall be determined in accordance with ASTM B987 and the test method shall be in accordance with ASTM D7028 (- A Standard Test Method for Glass Transition Temperature Polymer Matrix Composites by Dynamic Mechanical Analysis). The glass transition temperature shall be greater than the maximum continuous operating temperature of the offered HTLS conductor+25° C, and the Tg shall be measured as the peak in the Loss Modulas curve as per ASTM B897.)

1.31 Flexural Strength Test (for polymer composite core only)

Test method shall be as per ASTM D7264, ASTM D4475 or ISO 14125. The required values shall be based on the average of 5 test specimens

1.32 Bending Test on Composite Core

a. For type test, two composite core samples shall be tensioned to 7.5% of the rated tensile strength of the composite core and wrapped 180 degrees around a cylindrical mandrel. Tension may be measuredon one of the conductor ends or at the bending mandrel. If tension is measured at the bending mandrel, the load shall be 15% of the rated tensile strength. The application of bending and tension loads may be independent or combined provided that full bending load and tension load are simultaneously held for a minimum of 1 minute. The mandrel diameter shall be not more than 50 times the diameter of the composite core. After

completion of the two bending tests, one core sample shall withstand UTS test and one core sample shall be subjected to dye penetration test as per ASTM B987 section 14. Dye penetrant exposure time shall be 30+1/-0 minutes.
However, for extra high strength grade composite core, the mandrel diameter shall be not more than 60 times the diameter of the composite core.

b. For acceptance test, test each reel as follows: Two composite core samples, one from the start and one from the end of the reel, shall be tensioned to 7.5% of the rated tensile strength of the composite core and wrapped 180 degrees around a cylindrical mandrel. Tension may be measured on one of the conductor ends or at the bending mandrel. If tension is measured at the bending mandrel, the load shall be 15% of the rated tensile strength. The application of bending and tension loads may be independent or combined provided that full bending load and tension load are simultaneously held for a minimum of 1 minute. The mandrel diameter shall be not more than 50 times the diameter of the composite core. The core shall not break or split during the 1 minute hold.
However, for extra high strength grade composite core, the mandrel diameter shall be not more than 60 times the diameter of the composite core.

1.33 Chemical Analysis of Aluminium/ Aluminium Alloy and Composite core/ INVAR Core Wires

Samples taken from the Aluminium /Aluminium Alloy and core coils/ strands shall be chemically/spectrographically analyzed. The same shall be in conformity to the particulars guaranteed by the bidder so as to meet the requirements stated in this Specification.

Samples taken from the composite core shall be analyzes using DMA in accordance with above of this section 1.30 of Annex 11-4(1).

1.34 Chemical Analysis of Zinc

Samples taken from the zinc ingots shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in the Specification.

1.35 Galvanic Protection Barrier Layer Thickness

Determination of the minimum thickness of the galvanic protection barrier layer shall be done by microscopic examination and the minimum thickness shall be determined using an optical comparator or equivalent technique. The minimum thickness shall be as per requirement of latest edition of ASTM B987.

Annex 11-4a: Test Procedures of Conductor

1.1 UTS Test on Stranded Conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length between fixing arrangement suitably fixed on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to 100% of the UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and this value shall be recorded.

1.2 Corona Extinction Voltage Test

NOT APPLICABLE

1.3 Radio Interference Voltage Test

NOT APPLICABLE

1.4 D.C. Resistance Test on Stranded Conductor

On a conductor sample of minimum 5m length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero metre and subsequently one metre apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20^0C as per relevant IEC/BS/equivalent standard. The resistance corrected at 20^0C shall conform to the requirements indicated in the STP.

1.5 Chemical Analysis of Aluminium and Steel

Samples taken from the Aluminium and steel ingots/coils/strands shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this Specification.

1.6 Visual and Dimensional Check on Drums

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification.

1.7 Visual Check for Joints, Scratches etc.

Conductor drums shall be rewound in the presence of the Purchaser. The Purchaser shall visually check for scratches, joints etc. and that the conductor generally conform to the requirements of this Specification. Five percent (5%) to ten percent (10%) drums from each lot shall be rewound in the presence of the Purchaser's representative. The actual quantity will be discussed and mutually agreed to by the Supplier & Purchaser in the Quality Assurance Programme.

1.8 Dimensional Check on Steel and Aluminium Strands

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

1.9 Check for Lay-ratios of Various Layers

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this Specification.

1.10 Procedure Qualification test on welded Aluminium strands.

Two Aluminium/ Aluminium Alloy wire shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the breaking strength of individual strands.

1.11 Chemical Analysis of Zinc

Samples taken from the zinc ingots shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements stated in the Specification.

1.12 Galvanising Test

The test procedure shall be as specified in IEC: 60888. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

1.13 Torsion and Elongation Tests on Steel Strands

The test procedures shall be as per clause No. 10.3 of IEC : 60888. In torsion test, the number of complete twists before fracture shall not be less than that indicated in the STP. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 250 mm.

1.14 Check on Barrel Batten strength of Drums

The details regarding barrel batten strength test will be discussed and mutually agreed to by the Supplier & Purchaser in the Quality Assurance Programme.

TEST PROCEDURE OF STEEL EARTHWIRE

1.1 UTS Test

Circles perpendicular to the axis of the earthwire shall be marked at two places on a sample of earthwire of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate upto 50% of UTS and held

for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to 100% of UTS and held for one minute. The earthwire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.2 D.C. Resistance Test

On a earthwire sample of minimum 5m length two contact clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially at zero metre and subsequently one metre apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20^0C. The resistance corrected at 20^0C shall conform to the requirements of this Specification.

1.3 Chemical Analysis of Zinc

Samples taken from the zinc ingots shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements stated in the Specification.

1.4 Chemical Analysis of Steel

Samples taken from the steel ingots/coils/strands shall be chemically,/ spectrographically analysed. The same shall be in conformity to the requirements stated in this Specification.

1.5 Visual and Dimensional Check on Drums and its barrel strength test.

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification. The details regarding barrel strength test will be discussed and mutually agreed to by Contractor and Purchaser in the quality assurance programme.

1.6 Visual Check for Joints, Scratches etc. and Length of Earthwire

Ten percent drums from each lot shall be rewound in the presence of the Purchaser. The Purchaser shall visually check for scratches, joints etc. and see that the earthwire generally conforms to the requirements of this Specification. The length of earthwire wound on the drum shall be measured with the help of counter meter during rewinding.

1.7 Dimensional Check

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

1.8 Lay Length Check

The lay length shall be checked to ensure that they conform to the requirements of this Specification.

1.9 Galvanising Test

The test procedure shall be as per relevant IEC/BS/equivalent standard. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

1.10 Torsion Test

The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the stranded diameter of the strand the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number.

Annex 11-5: Engineering Documents to be Submitted by Contractor

Clause Reference	Document Description	Comment
11.2.1	Design of non-standard conductors	
11.6.1	Conductor erection-method statement	
11.6.2	Conductor joint schedule	See also clause 4.7
11.6.5	Inelastic extension -creep calculation	
11.6.6	Sag and tension calculations	See also clause 4.7
11.6.7	Temporary guy - support loading	
11.6.11	Temporary scaffolds - calculations & drawings	
11.6.12	Live line scaffolds - calculation & drawings	
11.7.2	Conductor grease - type test results	
11.7.5	Galvanising test results	If requested
11.7.5	Ingot zinc certificates	If requested
11.7.10	Aluminium clad steel certificates	If requested
11.7.9	Metallic materials - test certificates	
11.7.9	Conductor grease - type test results	
11.7.9	Conductor - sample test results	
11.7.9	Conductor grease - sample test results	
11.7.10	Certificate of conformity	
11.7.15	Bolt tightness	If requested
11.7.18	Final records - SIMM	If requested

Annex 11-6: Notification and Hold Points

Clause Reference.	Notification Point	Hold Point
11.2.1		Non-standard conductor
11.6.1		Method statement
11.6.2		Conductor joint schedule
11.6.3		Repair sleeves
11.6.6		Conductor sags & tensions
11.6.9	Conductor sagging	
11.6.11		Temporary scaffolds
11.6.12		Live line scaffolds
11.6.15	Joint in go fold conductors	
11.7.1	Conductor sample tests	
11.7.2		Conductor grease type tests
11.7.13		Jointing competence
11.7.17	Final line route inspection	Continuity test

Annex 11-7: Reference Standards

The reference standards and other documents referred to in this section of the specifications are listed below:

IEC 60104:	Aluminium-magnesium-silicon alloy wire for overhead line conductors
IEC 60888:	Zinc coated steel wires for stranded conductors
IEC 60889:	Hard drawn aluminium wire for overhead line conductors
IEC 61089:	Round wire concentric lay overhead electrical stranded conductor
IEC 61232:	Aluminium-clad steel wires for electrical purposes
IEC 61395	Creep test procedure for stranded conductors
ASTM B987	Standard Specification for Carbon Fibre Composite Core (CFCC/TS) for used in Overhead Electric Conductors
	CIGRE Electra No. 75 "Permanent elongation of conductors. Predictor equation and evaluation method". SC22 WG05.
	ICAO - Aerodrome Annex 14 Volume 1 "Aerodrome Design and Operation"

12. Vibration Dampers

12.1 Scope

12.1.1 General

Vibration dampers shall be either of the Stockbridge type comprising two weights attached via a messenger cable to a conductor clamp, or spiral type (SVD) for installation on the conductor, OPGW or all dielectric self-supporting (ADSS) optical fibre cable for which the damper is designed.

12.1.2 Types and Uses

Reference shall be made to **Annex 12-1** for details of the specified requirements.

12.2 Design

12.2.1. When installed in accordance with the manufacturer's recommendations the vibration damper(s) shall limit the aeolian vibration levels so that the conductor bending strain in the surface of the outer wires, determined in accordance with the CIGRE/IEEE recommendations, shall not exceed 300 micro-strains peak to peak at the vibration damper clamp and at the adjacent suspension clamp or tension joint (dead end). This requirement shall be met for all frequencies up to f=1480/d Hz, where d is the conductor diameter in mm. The manufacturer shall provide either suitable laboratory test results, field test results or calculations to demonstrate to the Employer's satisfaction that this requirement is met for each damper/conductor combination.

12.2.2. The vibration damper shall be designed to perform satisfactorily under the environmental factors, including conductor temperature variations, ultra-violet radiation, ozone and atmospheric pollutants applicable to the Site. The vibration damper shall not damage or cause corrosion to the conductor or individual strands when installed or during service.

12.2.3. The weights for Stockbridge type dampers can be of equal or unequal weight and can have symmetrical or unsymmetrical shape. They can also be symmetrically or asymmetrically located on the messenger cable.

12.2.4. SVDs shall be manufactured from solid poly-vinyl-chloride (PVC) rod.

12.2.5. Vibration damper clamps shall be designed to ensure that it is not possible for the vibration damper to be removed from the conductor, without initially undoing the clamp bolt. The clamp design shall also ensure that after the bolt has been correctly tightened, no slackening of the clamp can occur in service. The clamp bolt shall be suitably modified to prevent them being completely removed inadvertently. Any nut shall be captive.

12.2.6. For OPGW and ADSS optical fibre cable, the transmission properties of the optical fibres shall be unaffected by the vibration damper. During installation the interface between the clamp and the

conductor shall be filled with grease to exclude moisture and this fact shall be taken into account in the design.

12.2.7. The messenger cable shall comprise a suitable number of high tensile steel (according to clause no. 12.3.3) wire strands, (minimum number 19), shall be straight and sufficiently stiff to remain straight when the vibration damper is suspended by its clamp. The attachment points of the cable to the clamp and to the weights shall be protected from water ingress. No relative movement shall be permitted between the clamp and the cable.

12.2.8. Damper weights shall be of a ferrous or zinc material and the design shall ensure that there is no contact between the weight and the conductor or the messenger cable when in service. Drain holes (minimum diameter 6 mm) shall be provided where applicable to ensure that any water entering the weights can escape.

12.2.9. The active part length of SVD's must capture one loop length of vibration.

12.2.10. Dampers shall be free from visible and audible corona discharge and radio interference at the voltage levels specified except those designed exclusively for use on earthwires.

12.2.11. No audible noise shall be induced by the wind under any weather conditions.

12.3 Materials

12.3.1. Materials used in the manufacture of vibration dampers shall be of:

a) Adequate strength for the intended application, service life requirements and free from defects which would affect their performance;
b) Shall not be liable to intergranular or stress corrosion;
c) Compatible with the conductor material, such that there can be no deleterious effects on the conductor or vibration damper resulting from their use;
d) The material shall not adversely be affected in the long term by a coating applied for corrosion protection.

12.3.2. Vibration damper clamps shall be made from aluminium or aluminium alloy of a suitable grade complying with the requirements of BS EN 1559, 1676 and 1706.

12.3.3. Messenger wires shall be made from high tensile steel wire having a minimum tensile strength of 1220 N/mm².

12.3.4. Malleable cast iron weights shall be made of a suitable grade complying with either BS EN 1562 or BS EN 1563. Grey cast iron weights shall be made of a suitable grade complying with BS EN 1561.

12.3.5. Cast zinc weights shall be made of a suitable grade complying with BS EN 1774 and 12844.

12.3.6. Bolts and nuts shall be ISO Metric Precision Hexagon to BS 3692. Metal washers shall be ISO Metric to BS 4320 "Bright Series", and spring washers shall be ISO Metric to BS 4464.

12.3.7. Non-metallic materials used shall have:

a) A good resistance to ageing;
b) Capable of withstanding service temperatures and voltages without detrimental change of properties;
c) Adequate resistance to the effects of nitrogen oxides, ozone, ultra-violet radiation and air pollution over the whole range of service temperatures.

12.4 Workmanship

12.4.1 General

The dimensions of the vibration dampers shall be shown on the contract drawings, together with material types and grades, protective treatment and any other pertinent information. Contract drawings shall be submitted to the Employer for approval. **This is a Hold Point.**

12.4.2 Identification

All vibration dampers shall be marked to ensure a system of traceability. Where practicable, and unless otherwise agreed between the Employer and the manufacturer, vibration dampers shall be clearly and indelibly marked with 3mm minimum high characters as follows:

a) Identification of vibration damper (reference number);
b) Manufacturer's identification;
c) Date of manufacture (month and year);
d) Conductor diameter range, or designation;
e) Clamp bolt installation torque.

In the case of SVD's the information required above shall be provided on tear-off labels.

12.4.3 Installation Criteria

The supplier shall be responsible for determining (a) the exact number of vibration dampers required for each individual phase in each span of the transmission line, (b) distance of the vibration damper from the suspension clamp or mouth of the tension joint (dead end), (c) in-span separation and (d) clamp bolt installation torque. The rate for supply of vibration damper shall be quoted accordingly.

12.5 Protective Treatment

12.5.1Vibration dampers shall either be inherently resistant to atmospheric corrosion, or suitably protected against corrosion, such as may occur in transit, storage and in service. All ferrous parts which will be exposed to the atmosphere in service except steel wire, shall be protected by hot-dipped galvanizing to comply with the requirements of BS ISO 1461.

12.5.2Steel messenger wires shall be hot-dipped galvanized to comply with the requirements of BS EN 10244-2.

12.5.3The ingot zinc used for galvanizing shall comply with the requirements of BS EN 1179.

12.5.4All external threads shall be cut or rolled before hot-dipped galvanizing. Nuts to be galvanized shall be subsequently tapped 0.4 mm oversize and threads oiled.

12.5.5All galvanized materials shall be stored on packing, clear of the ground and away from all material that might stain or corrode the galvanizing. Black steel packing or bins shall not be used.

12.6 Quality Control

12.6.1 General

Type and sample tests shall be undertaken on the vibration dampers in accordance with the requirements of this specification.

Type tests specified in clauses 12.6.2 to 12.6.10 shall be undertaken on a minimum of three samples which shall be identical in all essential details with the vibration dampers to be supplied.

Contract drawings previously submitted to the Employer shall be available at the time of testing.

The Contractor/Supplier shall give the Employer the requisite period of notice prior to undertaking the tests, and shall submit to the Employer a test program and procedures. **This is a Hold Point.**

12.6.2 Conductor Damage

An undamaged length of conductor shall be tensioned to approximately 20% of its nominal breaking load and the vibration damper clamp shall be installed using the recommended torque. The position of the clamp shall be marked and then removed from the conductors. No indentations in the outer strands of the conductor shall be present in the area of the clamp.

For vibration dampers used on fibre optic earthwire, to check for any degradation in the optical fibre signal strength, the above test set-up shall be reused, except that the clamp installation torque shall be twice the recommended value. The degradation of the optical fibre signal shall be measured using an optical power metre.

Using a similar test set-up to that described above a spiral vibration damper shall be installed. The position of the SVD shall be marked and then removed from the conductor. No indentations in the outer strands of the conductor shall be present in the area of contact of the SVD.

12.6.3 Clamp Slip Test

For Stockbridge Vibration Dampers Clamp Slip Test shall be performed in accordance with IEC 61897. In the case of breakaway bolts, the installation torque shall be the design value minus the tolerance mentioned in the approved drawing.

The axial grip of the Spiral Vibration Damper (SVD) shall be measured using a similar test set-up described above. A co-axial tension of 2.5 kN shall be applied to the SVD, the relative movement of the SVD shall not exceed 0.5 mm after the 2.5 kN tensile force has been applied for one minute.

12.6.4 Clamp Bolt Tightening Test

For Stockbridge Vibration Dampers Clamp Bolt Tightening Test shall be performed in accordance with IEC 61897. The bolts or nuts shall be tightened to a torque 10 % above the specified installation torque. Clamps with breakaway bolts shall have the breakaway portion of the head removed prior to the test and shall be tightened with the specified torque value plus the tolerance mentioned in the approved drawing.

The threaded connection shall remain serviceable for any number (minimum five) of subsequent installations or removals and all components of the clamp shall be undamaged. No damage shall occur to the conductor inside the clamp.

12.6.5 Attachment of clamp to messenger cable

The test shall be performed in accordance with IEC 61897.

12.6.6 Attachment of weights to messenger cable

The test shall be performed in accordance with IEC 61897.

12.6.7 Corona

All vibration dampers, other than those used exclusively for earthwire applications shall be erected as in service (which may necessitate representation of the tower body) and subjected to a visible corona test. Corona tests shall be undertaken in accordance with the recommendations of IEC 61284. The visible corona extinction voltage shall not be less than the corona voltage mentioned in Annex 9-2. One sample shall be retained for reference purposes.

12.6.8 Vibration Damper Characteristics

This test is required to establish the characteristics of the vibration dampers used in the Damping Effectiveness test and the Fatigue test. Characteristics obtained before and after the Fatigue test shall be used as one of the acceptance criteria for the Fatigue test.

The test shall be performed in accordance with Clause no. 7.11.2 (Variant B) of IEC 61897.

12.6.9 Damping Effectiveness

12.6.9.1. This test is intended to verify that the damping system i.e. the vibration damper installed on the conductor is efficient in protecting the conductor from fatigue damage. The test shall be carried out in accordance with IEC 61897 or equivalent standards.

12.6.9.2. The same damper which has been subjected to the test in accordance with clause 12.6.8 shall be used. This test shall also be undertaken using spiral vibration dampers.

12.6.9.3. The test shall be conducted on a laboratory span with a minimum length of 30 m. The test span shall be arranged in accordance with CIGRE guides Electra No. 62 and IEEE Std. 664. The conductor shall be tensioned to 20± 1 % of its nominal breaking load.

12.6.9.4. The test shall be performed in accordance with clause no. 7.11.3.2 of IEC 61897.

12.6.10 Fatigue

12.6.10.1 The same vibration damper previously used for the vibration damper characteristics and damping effectiveness tests shall be used.

12.6.10.2 The test shall be performed in accordance with the Resonant Frequency Method of Clause 7.12 of IEC 61897. The damper shall be attached to a shaker and driven in a vertical direction for 10^7 (10 million) cycles. The minimum peak-to-peak amplitude at the damper clamp shall be equal to the conductor antinode amplitude peak-to-peak measured at the corresponding harmonic or 0.5mm.

12.6.10.3 After the fatigue test, the vibration damper shall again be subjected to the vibration damper characteristic test, to ensure that the dynamic behaviour of the vibration damper is maintained. The test shall be performed in an identical manner to that previously undertaken and the results shall be resented accordingly.

12.6.10.4 The acceptance criteria for this test, shall be in accordance with clause no. 7.12.4 of IEC 61897.
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12.6.11 Sample Tests

12.6.11.1. Following tests shall be performed during Sample Test in accordance with IEC 61897:

a) Visual examination
b) Verification of dimensions, materials and mass
c) Corrosion protection tests
d) Clamp slip test
e) Breakaway bolt test (only for Conductor dampers)
f) Conductor Damage test (in accordance with clause no.12.6.2 of this specification)
g) Clamp bolt tightening test
h) Attachment of weights to messenger cable
i) Attachment of clamp to messenger cable test
j) Vibration damper characteristic test

12.6.11.2. The Supplier shall give the Employer the requisite period of notice prior to undertaking sample tests. **This is a Notification Point.**

12.6.11.3. The number of samples selected for test shall be in accordance with the following requirements, where "p" is the number of fittings to be tested, and "n" is the number of fittings produced in a batch:

- p = 4 when n ≤ 500
- p= 4 + (1.5n)/1000 when n > 500

12.6.11.4. verification of compliance with the Approved drawings and that their shape and surface finish compare satisfactorily with the corona test reference sample shall form part of the sample test. Particular attention shall be given to markings required and to the finish of surfaces which come into contact with the conductor.

12.6.11.5. Dimension of the Vibration Dampers should be within dimensional tolerance stated on Approved drawings. This verification of materials shall be carried out by inspecting the supplier's documentation relating to material specifications, certificates of conformity or other quality documentation. The total mass of the damper complete with all its components shall comply with the mass shown on the approved drawing (within given tolerances).

12.6.11.6. During the sample tests, a vibration damper characteristic test in accordance with clause no.12.6.8 shall be undertaken. The damper Power Dissipation, The damper impedance and the phase angle between the reaction force and the velocity shall be measured and plotted against the frequency over the given frequency range. The corresponding curves for the type test shall also be plotted on the same graph.

12.6.11.7. If the randomly selected samples meet the test requirements, the batch(s) shall be deemed to comply with this specification. In the event of any samples not meeting the requirements, a further set of "p" samples shall be tested. Should any further failure occur the whole batch(es) from which the samples have been selected shall be liable to rejection.

12.6.12 Galvanizing

Tests for galvanized components of vibration dampers, shall be carried out at the works to ensure compliance with the requirements of BS ISO 1461. Hot dip galvanized messenger cable wires shall be tested in accordance with the requirements specified in IEC 60888 or BS EN 10244-2. Details of the test results shall be made available to the Employer.

Certificates relating to the ingot zinc used for galvanizing shall also be made available to the Employer.

12.6.13 Test Certificates

All metallic materials used in the manufacture of vibration dampers shall be covered by test certificates stating their mechanical and chemical properties to show compliance with this specification and IEC 61897, BS EN 1559, 1676, 1706, BS EN 1562, BS EN 1563, BS EN 1561, BS EN 1774, 12844 and BS EN 1676 as appropriate. Bolts and nuts shall be covered by the appropriate test certificate in respect of the test requirements of BS 3692.

Spiral vibration dampers shall be covered by the appropriate test certificate stating their mechanical and chemical properties. Test certificates for metallic, non-metallic materials and bolt and nuts shall be made available to the Employer. Test records, covering Type and Sample tests shall be made available to the Employer.

12.6.14 Certificate of Conformity

Copies of the following certificates/records shall also be forwarded:

a) Metallic and non-metallic material test certificates
b) Bolt and nut test certificates
c) Galvanizing test records
d) Ingot zinc certificate

Annex 12-1: Vibration Dampers Types & Uses

132 kV Line [Overland Portion]

Parameters	Conductor Type			
	Phase		Earthwire	OPGW
Conductor designation	Grosbeak	Grosbeak	7x3.25 GSW	To match 7 x 3.25 steel earthwire
Conductor material	ACSR	ACCC	GS	AS
Armour rods fitted	YES	YES	-	YES
Basic span (m)	as per Tower Section	as per Tower Section	as per Tower Section	as per Tower Section
Everyday temperature (°C)	as per Section 2. Technical Particulars	as per Section 2. Technical Particulars	as per Section 2. Technical Particulars	as per Section 2. Technical Particulars
Everyday tension (kN)	as per Section 11	as per Section 11	as per Section 11	as per Section 11
Vibration damper Type	Stockbridge	Stockbridge	Stockbridge	Stockbridge

Annex 12-2: Engineering Documents to be Submitted by Contractor

Clause Ref.	Document Description	Comments
12.4.1	Vibration dampers - contract drawings	
12.4.3	Installation procedures	
12.6.1	Type test programme and procedures	
12.6.1	Vibration dampers - type test certificates	
12.6.12	Galvanising test results	
12.6.12	Ingot zinc certificates	
12.6.13	Metallic material test certificates	
12.6.13	Bolts and nut material type test certificates	
12.6.13	Vibration dampers - type test results	
12.6.13	Vibration dampers - sample test results	
12.6.14	Certificate of conformity	

Annex 12-3: Notification and Hold Points

Clause Ref.	Notification Points	Hold Points
12.4.1		Contract drawings
12.6.1		Vibration dampers- type tests
12.6.11	Vibration dampers-sample tests	

Annex 12-4: Reference Standards

The reference standards and other documents referred to in this section of the specifications are listed below:

IEC 61284:	Overhead lines - Requirements and tests for fittings
IEC 61897:	Overhead lines - Requirements and tests for Stockbridge dampers
BS EN 10244-2:	Testing zinc coatings on steel wire for quality requirements
BS EN ISO 1461:	Specification for hot-dipped galvanising coating on iron and steel articles
BS EN 1774:	Specification for zinc alloys for die castings and zinc alloy die castings BS EN 12844
BS EN 1561:	Specification for flake graphite cast iron
BS EN 1559:	Specification for aluminium and aluminium alloy ingots and castings for general engineering purposes
BS EN 1676; BS EN 1706; BS EN 1563:	Specification for spherodical graphite cast iron
BS EN 1179:	Specification for ingot zinc
BS 3692:	Specification for ISO Metric hexagon bolts, screws and nuts
BS 4320:	Specification for metal washers for general engineering purposes. Metric series.
BS 4464:	Specification for Spring Washers for general engineering and automobile purposes. Metric series.
BS EN 1562:	Specification for Malleable cast iron
BS EN 1676:	Aluminium and aluminium alloys - Alloyed ingots for remelting
IEEE Trans Vol. PAS-85 (1966) No. 1	"Standardisation of Conductor Vibration Measurement"
IEEE Std. 664:	"Guide to Laboratory Measurement of the Power Dissipation Characteristics for Aeolian Vibration Dampers for Single Conductors".

13. Spacer Dampers – Not Applicable

14. OPGW and Optical Fibre Cable & Fittings

14.1 Scope

14.1.1 General

This section of the specification covers optical fibre cable suitable for incorporation into the earthwire (OPGW), associated fittings and non-metallic underground fibre optic cable.

14.1.2 Types and Uses

For details of the specified requirements reference shall be made to **Annexes 14-1 to 14-3**.

14.2 Design

14.2.1 Reliability

The overall system design of the fibre optic system shall meet the following minimum requirements:

a. Single failure or degradation in any optical fibre not more than one per year averaged over five years;
b. Failures or degradations affecting more than one optical fibre, not more than one in ten years;
c. Increase in optical system transmission attenuation due to accumulated ageing and other effects at the end of five years not more than 0.05 dB/km.

14.2.2 Fibre Optic Earthwire (OPGW)

14.2.2.1. The fibre optic earthwire to be supplied shall be suitable for installation on transmission lines, and shall be supplied complete with all necessary fittings and optical joint boxes. The earthwire, fittings and optical joint boxes shall be type approved.

14.2.2.2. The fibre optic earthwire shall comprise an optical sub-unit containing optical fibres, over which shall be laid aluminium, aluminium alloy or aluminium coated steel strands. Reference should be made to Section 11 for pertinent details of the overall earthwire.

14.2.2.3. The optical sub-unit shall withstand the temperature rise associated with the specified lightning fault current flowing in the earthwire without damage. The fibre optic earthwire shall be manufactured in continuous lengths of not less than 3 km.

14.2.3 Optical Fibres

14.2.3.1. Optical fibres shall be single mode fibre. The fibres shall be coded for ready identification at each end. Single mode fibres shall conform to ITU-T G652 or to IEC 60793-2-B1 and **Annex 14-2**.

14.2.3.2. The optical fibre coating material shall be mechanically strippable. The optical fibres shall be capable of being joined by fusion splicing techniques.

14.2.3.3. There shall be no measurable long term or short term optical attenuation change due to the temperature rise associated with a fault current flowing in an earthwire, or a lightning strike on the earthwire.

14.2.3.4. The optical fibres shall not be subjected to any critical stresses when the cable is at its maximum system loading, reference **Annex 11-3**.

14.2.3.5. After finalisation of the drum lengths, the Contractor/Supplier shall submit calculations for the expected overall attenuation and dispersion. **This is a Hold Point.** This will be compared with the actual values measured after a completion of the installation.

14.2.4 OPGW Fittings

14.2.4.1. The fibre optic earthwire shall be used with approved conductor fittings in accordance with sections 10 and 12 of the specifications. The application of these fittings shall not damage the earthwire or the fibres, either mechanically or optically.

14.2.4.2. At each support, a bypass device shall be provided to guide the cable around the earthwire fittings associated with the support.

14.2.4.3. Earthwire bonds similar to those specified in Section 10 of the specification shall be provided.

14.2.4.4. The cable run from the earthwire to the splice enclosure shall be secured to the support and suitable protection shall be provided to prevent damage from shotgun attack or other accidental means.

14.2.5 Optical Joint Boxes

14.2.5.1. Optical joint boxes shall be provided to protect the splice joints of optical fibres, either when individual lengths of fibre optic OPGW, are jointed, or between the fibre optic earthwire and the underground fibre optic cable. The optical joint boxes shall protect the splice joint from both mechanical and environmental damage.

14.2.5.2. The optical joint boxes shall preferably be of hood/dome type with single end plate in bottom and shall be fitted to the support immediately above the anti-climbing device.

14.2.5.3. The joint boxes shall consist of an external steel or die cast aluminium housing and provide protection to IEC 60529 IP447, and an internal die cast aluminium or high impact plastic ABS box to IEC 60529 IP54.

14.2.5.4. The external housing shall be designed so that rain water is directed away from the door, and there shall be no water ingress when the door is opened.

14.2.5.5. The door of the box shall be fitted with captive hinges and shall be fastened shut by screw fixings. A hasp shall be provided on the door capable of taking a 10mm padlock.

14.2.5.6. The bottom of the box shall be fitted with two gland plates, each gland plate shall have two entry points. The gland plates shall be interchangeable, one style shall be used for fibre optic earthwire, the other for underground fibre optic cable. The joint boxes shall be supplied complete with all fittings to secure and seal the cable in the gland plates or blank the unused spigots. Cable cleats to secure the fibre optic OPGW or underground cable shall be fitted inside the box. The cleats shall not have a detrimental effect on the performance of the optical fibres when tightened to the recommended torque.

14.2.5.7. The top and bottom of the joint box shall be vented, and the vents provided with vermin shields.

14.2.5.8. An M12 earthing boss complete with an M12 galvanised nut and lock washers shall be provided on the outside of the box.

14.2.5.9. The interior box shall be mounted on brackets inside the external housing and shall be capable of easy removal, complete with the optical fibre tails. The seal around the box shall be capable of withstanding specified temperatures.

14.2.5.10. The box shall be supplied complete with internal splice cassettes to accommodate the required number of splices. Glands shall be fitted to accommodate either the fibre optic OPGW, or underground fibre optic cable.

14.2.6 Fixing Clamps

A bolted clamping system shall be used to attach the OPGW to the inside of the support without drilling or modifications to the support steelwork. The clamping system shall be capable of use with galvanised steel angle sections varying between 40 and 200 mm wide and accommodating either single, double or multiple lengths of OPGW.

The attachment clamps shall be capable of being attached and detached from the support, without affecting the OPGW.

14.2.7 Non-Metallic Underground Fibre Optic Cable

The fibre optic cable shall be circular in cross section and shall be designed so that any cable strain is not directly imported on the optical fibres. The cables shall not include any metallic components, to prevent high induced voltages when used in switching or substation compounds.

Optical fibres shall be in accordance with chapter14.2.3 and shall match the OPGW, fibres in type and colour.

14.3 Materials

14.3.1 Fibre Optic Earthwire

External aluminium, aluminium alloy or aluminium coated steel strands shall be in accordance with the requirements of Section 11 of the specification. OPGW of dissimilar materials such as stainless steel tube with aluminium-clad steel wire strands are not allowed.

14.3.2 Optical Joint Boxes

Optical joint boxes shall be made from either a suitable grade of aluminium alloy complying with the requirement of BS EN 1559, 1676, 1706 and/or BS EN 1676, or steel complying with requirements of BS 3100.

14.3.3 Fixing Clamps

Fixing clamps shall be made from a suitable grade of aluminium alloy comprising with the requirements of BS EN 1559, 1676, 1706 and/or BS EN 1676. Bolt quality shall be grade 4.6 according to ISO 898-1. Bolts and nuts shall be ISO Metric Black Hexagon to BS 4190, and shall unless otherwise specified be threaded ISO Metric Coarse Pitch to BS 3643: Part 2, Tolerance Class 7h/8 g.

14.4 Workmanship

14.4.1 Contract Drawings

Contract drawings for fixing clamps and optical joint boxes shall in addition to the dimension show material types and grades, protective treatment and any other pertinent information. Design drawings shall be submitted to the Employer for approval. **This is a Hold Point.**

14.5 Protective Treatment

14.5.1 Fibre Optic Earthwire

Where two layers of wire strands are provided over the optical sub-unit, the external surface of the optical sub-unit and the inner strand layer shall be greased, using an approved conductor grease (Ref. Section 11 of the Specification).

14.5.2 Ingress of Moisture

The cable shall be capped before shipment to prevent the ingress of water.

14.5.3 Optical Joint Boxes

Optical joint boxes (steel exterior housings) shall be hot dipped galvanised after manufacture to meet the requirements of BS ISO 1461. The boxes shall be sufficiently rigid so that there is no distortion of either the box or its door after galvanising.

14.6 Installation

14.6.1 General

14.6.1.1 The supplier of the OPGW will be responsible for the supervision of installation by the Contractor, to ensure that overall system reliability requirements are met. To ensure that this is undertaken, the supplier will provide the services of a suitably qualified/experienced installation supervisor, who shall supervise the installation of the Works and shall advise the Engineer and the Contractor in matters of methods procedures and precautions to be followed and will be responsible for all matters pertaining to the quality of the installation. The supplier's installation supervisor shall make at least four visits of 2 (two) weeks each during progress of OPGW installation work for the purpose.

14.6.1.2 The Contractor shall provide the Employer with a method statement giving sequential details of the stripping procedure and the optical fibre jointing (splicing) procedure. The method statement shall take full cognisance of the manufacturer's installation instructions.

14.6.1.3 The method statement shall be submitted to the Employer for acceptance the requisite period prior to stringing or optical fibre jointing commences. **This a Hold Point.**

14.6.2 Workmanship

The Contractor shall ensure that the fibre optic cables are not strained or damaged either mechanically or optically during stringing and/or jointing. If necessary the Contractor shall demonstrate the suitability of his proposed method, including the choice of running blocks prior to the commencement of stringing operations.

14.6.3 Optical Fibre Joints

Optical fibre joints either in the OPGW, or between the OPGW, and the non-metallic underground fibre optic able shall be housed in optical joint boxes. The joint boxes shall be located immediately above the anti-climbing device for convenient access by technical personnel. All joint boxes shall be earthed to the support steelwork using approved multi-wire/multi-strand flexible aluminium earthing bonds.

14.7 Quality Control

14.7.1 General

Type, sample and routine tests shall be undertaken on OPGW, their associated fittings, non-metallic underground fibre optic cable and the optical fibres in accordance with the requirements of this specification, ITU-T G652, IEC 60793 and IEC 60794 as appropriate. Contract drawings previously submitted to the Employer shall be available at the time of testing.

The Contractor/Supplier shall give the Employer the requisite period of notice prior to undertaking the tests, and shall submit to the Employer a test programme and procedures for approval. **This is a Hold Point.**

Type test of offered OPGW will be waived during execution of the Contract if the Contractor submit the satisfactory type test reports of same OPGW. In case, the type test of OPGW is conducted during execution of Contract, the test will be performed in presence of Employer's Engineers.

14.7.2 OPGW

14.7.2.1 Type Test

a) Tensile Performance

The test shall be undertaken in accordance with IEC 60794-4-10 and IEC 60794-1-21: Method E1. Tension shall be steadily increased to 70 % RTS and released back to initial load. The rate of increase of load shall be as per IEC 61089 Annex B. Minimum length of cable under tension shall be as per IEC 60794-4-10. The minimum test length of optical fibre for attenuation measurement and for fibre strain measurement shall be as per IEC 60794-4-10. There shall be no permanent change in the fibre attenuation at the specified wavelength after the test, while the change in attenuation during the test shall be less than 0.05db/km from zero load to 70% of the UTS of the cable. The fibre strain must be less than 0.05% at 70% of the UTS of the cable.

b) Stress-Strain

The test shall be undertaken in accordance with IEC 60794-4-10. The load conditions and the rate of increase of load shall be as specified in IEC 61089 Annex B. A sample of OPGW shall be as per IEC 60794-4-10. A sample of OPGW complete with the proposed end fittings shall be subject to a stress-strain test. There shall be no visual change to the OPGW strands after the test. The Modulus of Elasticity of the OPGW shall be measured.

c) Crush

The crush test shall be undertaken in accordance with the recommendations of Method E3 of IEC 60794-1-21. The test shall be undertaken by applying a 10kN load for 10 min to the OPGW via two 100mm x 100mm flat plates. There shall be no measurable permanent change in the fibre attenuation at the specified wavelength, while any temporary change in attenuation shall be less than 0.1db

d) Impact

The impact test shall be undertaken in accordance with the recommendations of Method E4 of IEC 60794-1-21. The test shall be undertaken by dropping a 4kg weight from a height of 150mm on the OPGW. After 20 repeated applications, there shall be no measurable change in fibre attenuation at the specified wavelength, while any temporary change in attenuation shall be less than 0.1 db.

e) Temperature Cycling

The optical performance under temperature cycling shall be tested in accordance with IEC 60794-4-10 and Method F1 of IEC 60794-1-22 with T_A and T_B as specified in Annex 14-1 The test should be undertaken twice. Cable Sample length, soak time at extreme temperatures, temperature change rate shall be as per IEC 60794-4-10. Acceptance criteria shall be as per IEC 60794-4-10.

f) Water Ingress

The optical sub-unit shall be tested for water ingress in accordance with IEC 60794-4-10.

g) Fault Current

A sample of OPGW not less than 10m in length shall be subject to a fault current pulse. The fault current pulse specified in Annex 14-1 shall be supplied in less than 1s after the conductor has been raised to the specified initial temperature mentioned in Annex 14-1. During the test the temperature of the optical sub-unit shall be measured, the temperature immediately after the current pulse shall be less than the specified temperatures as per IEC 60794-4-10. No of cycle shall be as per 60794-4-10. Interval between each pulse shall be enough so that the sample has stabilized at initial temperature. After the second impulse the OPGW shall be dismantled and the optical cable examined throughout its length for any signs of deterioration. Fibre optic attenuation shall be measured using light source and power meter connected to each end of the test fibre. The test length of optical fibre shall be minimum 100m. Permanent increase in attenuation shall be measured 30mins after the test. Optical attenuation shall not exceed 0.05dB/km.

h) Lightning Strike

The Contractor shall submit his proposals to the Employer to demonstrate the effectiveness of the OPGW to withstand the effects of a lightning strike. The test shall consider both an initial stroke and a power follow through. The initial peak current shall be as specified in Annex 14-1. The test shall be carried out on a sample of OPGW not less than 1m long as per Method H2 of IEC 60794-1-24. The acceptance criteria shall be (i) attenuation change is required to be less than 0.05dB/km (ii) if any wire(s) are found broken, then the calculated residual strength for remaining unbroken wires shall not be less than 75% of the original declared rated tensile strength of the completed OPGW.

14.7.2.2 Routine Test

14.7.2.2.1. OPGW on all drums shall be tested for mechanical Tests including measurement of dimensions of steel and aluminium (Al) wires and overall diameter of OPGW, measurements of thickness of Al on ACS wires, twist test of steel & Al wires, torsion test of steel wires, checking of lay length & lay ratio of layers, checking of lay directions, breaking load test of steel and Al wires and DC resistance measurement of Al and ACS wires at the factory by the manufacturer as routine tests.

14.7.2.2.2. In addition, attenuation shall be measured on each fibre of all OPGW with OTDR at the factory by the manufacturer as routine test.

14.7.2.2.3. The test results shall be available with the manufacturer and shall be submitted to the Employer, if requested.

14.7.2.3 Sample Test

Samples taken on random sampling basis from the OPGW drums ready for shipment against each batch shall be tested. 10% of the drums shall be tested for Factory Acceptance Test (FAT). Following tests are to be done as FAT at the factory by the manufacturer.

On Complete OPGW (As per IEC 60794 and IEC 61089):

1) Diameter of cable
2) Mechanical Test of OPGW/ Breaking strength test
3) Lay length, lay ratio, lay direction of each layer
4) DC resistance of cable
5) Weight per unit length of cable
6) Visual inspection of the cable elements

On Aluminium wires (As per IEC 60889):

1) Dimension of Individual Al wires
2) Wrapping test of aluminium wire
3) Breaking load Test of individual Al wire
4) DC Resistance Test of Al

On ACS wires (As per IEC 61232):

1) Dimension of Individual ACS wires
2) Al thickness on ACS Wires
3) Breaking load Test of individual ACS wire
4) DC Resistance Test of ACS wires
5) Torsion Test of ACS wires
6) Elongation Test of ACS wires
7) Stress at 1% Elongation

On Steel wires (As per IEC 60888):

1) Dimension of Individual Steel wires
2) Wrapping test of steel wire
3) Torsion Test of steel wires
4) Breaking load Test of individual Steel wire
5) Elongation Test of steel wires
6) Stress at 1% Elongation
7) Zinc Coating test

On Optical Fibre:

1) Attenuation of each fibre with OTDR.
2) Others as per ITU-T G65 and IEC 60793

14.7.3 Optical Fibres

Optical fibres shall be tested in accordance with the requirements of ITU-T G652 and IEC 60793 as appropriate.

14.7.4 Optical Joint Boxes

Optical joint boxes shall be visually inspected to ensure they meet the specified requirements. If the external housing or its door shows any signs of distortion or any galvanizing damage then the box shall be rejected. Details of the inspection shall be recorded and shall be made available to the Engineer upon request.

14.7.5 Non-Metallic Underground Fibre Optic Cable

Non-metallic underground fibre optic cable and the optical fibres shall be tested in accordance with the requirements of ITU-T G652, IEC 60793 and IEC 60794 as appropriate.

14.7.6 Fibre Optic Cables

All fibre optic cables shall be tested prior to despatch using an OTDR on each fibre.

14.7.7 Test Certificates

Test records, covering Type and Sample tests shall be made available to the Employer.

14.7.8 Certificates of Conformity

When requested copies of the following certificates/records shall also be forwarded:

a. Optical joint boxes visual inspection records;
b. Routine test records;
c. The records of the OTDR test results.

14.7.9 Installation

14.7.9.1. The following tests shall be undertaken by the Contractor:

a. Prior to installation the fibre optic cable shall be tested with an OTDR on each fibre to ensure that no physical damage has occurred to the fibre during delivery and shall be compared with the results prior to despatch;
b. After installation the above test shall be repeated to ensure that no damage has occurred to the fibre during installation;
c. An end-to-end attenuation measurement shall be taken in each direction on each fibre using an optical source and optical power meter.

14.7.9.2. The overall attenuation of the installed cable shall not exceed that calculated using the attenuation and splice loss values specified in **Annex 14-2**.

14.7.9.3. The Contractor shall give the Engineer the requisite period of notice prior to commencing the tests. **This is a Notification Point.** Details of the test results shall be submitted to the Employer.

14.7.9.4. The supplier of the OPGW is requested to co-operate with the Fibre Optic Terminal Equipment Supplier (if this is under a separate contract) and shall supply all technical data requested.

14.8 Test Equipment

Reference should be made to **Annex 14-3** for details of the test equipment required.

14.9 Maintenance Equipment and Tools

Reference shall be made in the price schedule, mandatory spare part and tools.

Annex 14-1: OPGW Design Requirements

Description	Unit	132kV
Number of fibres		48
Fault current (1 second)	(kA)	5
Initial temperature	(°C)	40
Leading edge	(µs)	1.2
Lightning initial peak current (0.5 second)	(A)	Class 1 as per IEC 60794
Tail	(µs)	50
Power follow through	(Coulomb)	Class 1 as per IEC 60794
Temperature cycling test T_A	(°C)	5
Temperature cycling test T_B	(°C)	40

Annex 14-2: Single Mode Optical Fibre Cable Requirements

Coating diameter		µm	250 ± 15
Cladding diameter		µm	125 ± 3
Cladding non-circularity		%	≤2
Mode field diameter		µm	8.6 ~ 9.5
Mode field concentricity error		µm	≤1
Cut off wave length		nm	≤1,270
Attenuation at (maximum average)	1285 nm 1330	dB/km	≤0.40
Attenuation at (maximum average)	1550 nm	dB/km	≤0.25
Zero dispersion wave length		nm	≤1,321
Chromatic dispersion at	1285 nm 1330	ps/(km-nm)	≤3.50
Chromatic dispersion at	1550 nm	ps/(km-nm)	≤20
Individual splice loss		dB	≤0.10
Mean splice loss		dB	≤0.06

Annex 14-3: Test Equipment

OTDR

Annex 14-4: Engineering Documents to be Submitted by Contractor

Clause Reference	Document Description	Comment
14.2.3	Expected overall attenuation and dispersion	
14.4.1	Optical Joint Boxes - Contract drawings Fixing clamps - contract drawings	
14.6.1	Installation instructions	
14.6.1	Method statement	
14.7.1	OPGW fittings, Non-metallic underground fibre optic cable and optical fibres - type test certificates	
14.7.2	Type test programme	
14.7.2	OPGW - fatigue life	Documentary evidence
14.7.2	OPGW - lightning strike	Test proposals
14.7.2	OPGW - routine tests	Test proposals
14.7.4	Optical joint boxes - visual inspection test records	
14.7.9	OPGW fittings and optical fibres - type test records	
14.7.9	OPGW fittings& optical fibres- routine test records	
14.7.8	Certificate of conformity	
14.7.9	Installation test records	

Annex 14-5: Notification and Hold Points

Clause Reference	Notification Point	Hold Point
14.2.3		Optical Fibres
14.2.6		Fixing clamps
14.4.1		Contract drawings – method statement
14.6.1		Installation – Type test programme
14.7.1		Quality Control – Lightning strike – test proposals
14.7.9	Installation tests	

Annex 14-6: Reference Standards

The reference standards and other documents referred to in this section of the specifications are listed below :

IEC 60529:	Classification of decrees of protection provided by enclosures
IEC 61089:	Round wire concentric lay overhead electrical stranded conductors
IEC 60793- 1:	Optical Fibres Part 1: Generic Specification
IEC 60793-2:	Optical Fibres Part 2: Product Specification
IEC 60794-1:	Optical Fibre Cable Part 1: Generic Specification
IEC 60794-2:	Optical Fibre Cable Part 2: Product Specification
BS ISO 1461:	Specification for hot dip galvanised coatings on iron and steel articles
BS EN 1559:	Specification for Aluminium and aluminium alloy ingots and castings for general engineering purposes
BS EN 1676; BS EN 1706; BS 3100:	Specification for steel castings for general engineering purposes
BS 3643:	Ingot zinc
BS 4190:	Specification for ISO Metric hexagon bolts, screws and nuts
BS EN 1676:	Aluminium and aluminium alloys - Alloyed ingots for remelting
BS EN 10025:	Specification for hot rolled products of non-alloying structural steels and their technical delivery requirements.
ISO 898-1:	Mechanical properties of fasteners made of carbon steel and alloy steel
ITU-T G652:	Characteristics of single mode optical fibre cable.

15. Aircraft Navigation (Obstruction Aids)

15.1 Scope

15.1.1 Types and Uses

The type and arrangement of all aircraft navigation (obstruction aids) i.e. aircraft warning lights (solar or LV powered), solar arrays, batteries and aircraft warning spheres shall be approved by the Employer.

Reference is made to **Annex 15-1** for the detailed specific requirements.

15.2 Design

15.2.1 General

All aircraft navigation (obstruction aids) shall be so designed as to:

(a) Withstand the mechanical loads relevant to the installation-service-maintenance conditions and environmental effects;
(b) Minimize the number of parts and the possibility of incorrect assembly and installation;
(c) Ensure that individual components are secured against becoming loose in service; all threaded fasteners shall be locked;
(d) Utilize materials which have sufficient strength, ductility and environmental resistance to withstand the static dynamic loading;
(e) Avoid damaging the earthwire under all service conditions;
(f) Comply with the requirements of ICAO Aerodromes Annex 14 Volume 1 Aerodrome Design and Operation and Aerodrome Design Manual Part 4 unless stated to the contrary.

15.2.2 Obstruction Lights (Solar Powered)

The complete solar powered obstruction light system i.e. obstruction lights, photovoltaic cells, storage batteries and control equipment, shall be designed to ensure maximum unattended operation with minimal maintenance, i.e. maximum once per year.

15.2.2.1. Obstruction lights shall consist of one main and one standby omnidirectional lamps in compliance with **Annex 15-1**.

15.2.2.2. The light shall be equipped with LED clustered lamps with a rated life of at least 20,000 hours.

15.2.2.3. The light shall be designed to allow it to be directly installed on any vertical or horizontal surface of the tower. In case the power adapter cannot be installed at the lamp locations, an extension cable assembly with lamp holder shall be provided.

15.2.2.4. The operation of the lights during darkness or poor visibility shall be controlled by a photoelectric switch. The levels of illuminance falling on a vertical surface for activating the lights shall be agreed with the Engineer.

15.2.3 Obstruction Lights (LV powered)

15.2.3.1. Obstruction lights shall consist of one main and one standby omnidirectional red lamps in compliance with **Annex 15-1**.

15.2.3.2. The luminous intensity shall be medium and have the longest possible rated life, which should not be less than 10,000 hours.

15.2.3.3. The light shall be designed to allow it to be directly installed on any vertical or horizontal surface on the tower. The operation of the light during darkness or poor visibility shall be controlled by a photo-electric switch. The level of illuminance falling on a vertical surface for activating the lights shall be agreed with the Engineer.

15.2.3.4. At the base of the tower immediately above the A.C.D. level a termination box shall be provided complete with isolator and other control gear as necessary.

15.2.3.5. The termination box shall be manufactured from either steel or die cast aluminium to provide protection to IEC 60529 IP 55.

15.2.4 Photo-Voltaic Cells (Solar Array)

15.2.4.1. The photo-voltaic cells in conjunction with the storage batteries shall be designed to have the maximum system reliability and battery life. Solar panels shall not be designed to provide maximum power during, periods of peak solar radiation, but to provide power at an essentially constant rate over the annual solar cycle. The minimum charge state shall provide adequate reserve for weather anomalies which may comprise up to one month of continuous heavy cloud cover, whilst the maximum charge state achieved during favourable conditions shall not exceed the rated battery capacity to prevent the possibility of overcharging the battery causing electrolyte evaporation.

15.2.4.2. For protection of the solar array from reverse currents during darkness, a diode shall be placed in series with the array.

15.2.4.3. The complete solar panel shall be designed to ensure that the maximum electrical Output degradation shall not exceed 10 percent over a 10 year period.

15.2.4.4. The photovoltaic cells shall be redundantly interconnected and provided with integral bypass diodes to prevent cell overheating due to localized shading and system continuity in the event of cell circuit failure.

15.2.4.5. The complete solar panel shall be suitably sealed in an aluminium frame which effectively isolates the cells from thermal and mechanical shock and-prevents the ingress of moisture.

15.2.5 Support Framework

The solar array support framework shall be designed to mount the complete solar panel at the optimum tilt angle, and to resist the imposed wind loading calculated in accordance with Section 8 of this specification.

15.2.6 Storage Batteries

Vented lead acid electrolyte batteries of an extremely low self-discharging type shall be used in conjunction with photo-voltaic cells. Catalytic recombinator caps shall be used to reduce water loss to very low levels. The batteries shall have proven cycling abilities in conjunction with photo-voltaic operation and shall be designed to provide power during periods of low solar radiation, which shall not be less than a minimum of 5 days, reserve storage plus specified low solar storage calculated from the optimum storage array, size associated with the location.

A regulator shall be used to protect the battery from overcharging and a low voltage disconnector from excessive discharge.

The batteries must have a stable voltage characteristic with less than 5 percent variation in nominal output voltage from fully charged to discharged.

Separate batteries and chargers shall be provided for each light.

15.2.7 Battery Enclosure

A suitably designed battery enclosure shall be provided for housing the batteries and control unit at the specified work platform level.

The enclosure shall have hinged access panels for ease of battery maintenance, vent holes in the base and ventilation at the top to provide adequate air through venting of gases from the batteries. Maximum and minimum electrolyte levels of all battery cells shall be clearly visible.

15.2.8 LV Cables

All LV cables and cabling shall be in accordance with the appropriate British Standards and local health and safety requirements.

15.2.9 Aircraft Warning Spheres

Aircraft warning spheres shall be a minimum of 600 mm diameter and shall be fitted to the earthwire.

Externally, the spheres shall be coloured red or orange to meet the local environmental conditions and installed alternatively with white spheres. All component bolts shall be captive and preference shall be given to use of shear-head clamp tightening bolts. Factory formed helical armour rods shall be fitted to protect the earthwire at aircraft warning sphere locations.

15.2.10 Tower Painting

15.2.10.1. Painting of towers to comply with the requirements of ICAO and local aviation authorities, shall be undertaken when specified by the Engineer.

15.2.10.2. The paint system shall comprise an etch primer, under and gloss coat which shall be formulated to take into consideration the local environmental conditions. The paint shall not present a health hazard and shall conform to relevant current health and safety requirements.

15.2.10.3. Reference shall be made as appropriate to BS 5493. Details of the proposed painting system shall be submitted to the Engineer. **This is a Hold Point.**

15.2.10.4. For details of the extent of the painting requirements reference should be made to **Annex 15-1.**

15.3 Materials

15.3.1. Materials used in the manufacture of aircraft navigation (obstruction aids) shall be of:

(a) Adequate strength for the intended application and service life requirements (including mechanical loads, vibrations, electrical currents and environmental effects) and free from defects which would affect the performance of the equipment.
(b) Shall not be liable to intergranular or stress corrosion.
(c) The material shall not be adversely affected in the long term by a coating applied for corrosion protection.

15.3.2. Photovoltaic cells shall comprise matched monocrystalline silicon cells enclosed by a glass front surface and a rear composite layer to provide the optimum thermal and electrical performance.

15.3.3. The glass front surface shall have similar thermal expansion characteristics to the photovoltaic cell, shall be resistant to impact and abrasion by wind-blown materials and shall be self-cleaning under the action of rain.

15.3.4. All mild steel used in the manufacture of the support framework shall comply with the requirements of BS EN 10025 or BS EN 10210. Minimum steel grade shall be S275JR and S275JOH respectively.

15.3.5. Aluminium or aluminium alloy used in the manufacture of the complete solar panel frame shall comply with the requirements of BS 1474.

15.3.6. Cast aluminium and aluminium alloy fittings shall be made from aluminium or aluminium alloy of a suitable grade, complying with the requirements of BS 1490 and/or BS EN 1676.

15.3.7. Aircraft warning spheres shall be made from either glass reinforced polyester resin or aluminium sheet, having a minimum specified thickness. Aluminium sheet shall comply with the requirements of BS EN 485

15.3.8. Bolts and nuts shall be either ISO Metric Black Hexagon to BS 4190 threaded ISO Metric Course Pitch to BS 3643: Part 2 Tolerance Class 7H/8g, or ISO Metric Precision Hexagon to BS 3692.

Metal washers shall be either to BS 4320, Form E, Grade 4.6 or 'bright series'. Spring Washers shall be ISO Metric to BS 4464.

15.3.9. If shear-head type bolts are used they shall be clearly marked so after the correct torque has been applied, the installed bolt may be clearly identifiable from the ground.

15.3.10. Non-metallic materials shall have good resistance to ageing and shall have adequate resistance to the effects of nitrogen oxide, ozone, ultra-violet radiation and air pollution.

15.3.11. Glass reinforced polyester resin mouldings for aircraft warning spheres shall be in accordance with BS 4549, Part 1.

15.3.12. All paints used shall be suitable for use with and not adversely affect galvanized steel.

15.4 Workmanship

The dimensions of all aircraft navigation (obstruction aids) equipment shall be shown on the contract drawings. Contract drawings including cabling layouts shall be submitted to the Engineer. **This is a Hold Point.**

All equipment shall be marked to ensure a system of traceability for each component of the equipment. Where practicable, and unless otherwise agreed between the Engineer and the Contractor /Supplier, equipment shall be clearly and indelibly marked with 6 mm high characters as follows:

(a) Identification of equipment (reference number);
(b) Maker's identification;
(c) Date of manufacture (month and year);
(d) Cast code - if appropriate;
(e) Conductor diameter range - if appropriate;
(f) Fitting bolt installation torque - if appropriate.

15.5 Protective Treatment

All parts of the aircraft navigation (obstruction aids) equipment shall either be inherently resistant to atmospheric corrosion or suitably protected against corrosion, such as may occur in transit, storage and service. All ferrous parts which will be exposed to the atmosphere in service shall be protected by hot-dipped galvanizing to comply with the requirements of BS 729. All manufacturing processes shall be completed prior to galvanizing.

The ingot zinc used for galvanizing shall comply with the requirements of BS 3436.All external threads shall be cut or rolled before hot-dipped galvanizing. Nuts to be galvanized shall be subsequently tapped 0.4 mm oversize and the threads oiled.

15.6 Installation

Aircraft navigation (obstruction aids) shall be installed strictly in accordance with the Supplier's instructions.

The proposed means of paint application shall take full cognizance of local environmental requirements and shall be subject to the approval of the Engineer. **This is a Hold Point.**

15.7 Quality Control

15.7.1 General

Type, sample and routine tests as appropriate shall be undertaken on both individual items and complete system, e.g. obstruction lights, solar panels, storage batteries etc. in accordance with the requirements of this specification. The test procedure must clearly demonstrate the suitability of the complete system to meet the environmental and operational conditions specified. The Contractor's proposals for these tests shall be submitted to the Engineer for approval before manufacture commences. **This is a Hold Point.**

Contract drawings previously submitted to the Engineer shall be available at the time of testing. The Contractor/Supplier shall give the Engineer the requisite period of notice prior to undertaking the type and sample tests, and shall submit to the Engineer for approval a test programme and procedures. **This is a Hold Point.**

15.7.2 Galvanising

Tests for galvanised equipment shall be carried out at the works to ensure compliance with the requirements of BS 729. Details of the test results shall be made available to the Engineer upon request.

15.7.3 Test Certificates

15.7.3.1. All metallic materials used in the manufacture of the equipment shall be covered by test certificates stating their mechanical and chemical properties to prove compliance with requirements of this specification and BS EN 10210, BS EN 10025, BS EN 485, BS 3 1 00, BS 4190, BS 1474, BS 1470 as appropriate.

15.7.3.2. Bolts and nuts shall be covered by the appropriate test certificate in respect of either BS 4190 or BS 3692. Tests certificates for metallic materials, bolts and nuts and where appropriate non-metallic materials shall be made available to the Engineer upon request.

15.7.3.3. Where type and sample tests are undertaken test certificates covering these tests shall be made available to the Engineer.

15.7.3.4. Where routine tests are undertaken test certificates covering the tests shall be made available to the Engineer upon request.

15.7.4 Certificate of Conformity

Prior to despatch the Contractor/Supplier shall forward to the Engineer requisite copies of the completed Certificate of Conformity. The certificate shall be supported by copies of the appropriate test reports of any type and/or sample tests undertaken.

When requested copies of the following certificates/records shall also be forwarded:

(a) Metallic material test certificates
(b) Bolt and nut test certificates
(c) Non-metallic material test certificates
(d) Galvanizing test records
(e) Routine test records.

15.7.5 Site Tests

Prior to commissioning the Contractor shall submit to the Engineer his proposals for checking/testing the complete installation. **This is a Hold Point.** The Contractor shall give the Engineer the requisite period of notice prior to undertaking the agreed commissioning tests. **This is a Notification Point.**

15.7.6 Painting

Prior to the commencement of painting the Contractor shall submit to the Engineer his proposals for checking/testing the routine quality of the Painting. **This is a Hold Point.**

Annex 15-1: Aircraft Navigation (Obstruction Aids)

Tower painting as per ICAO requirements		Yes
Tower painting as per local requirements		-
Obstruction lights		Solar powered
L.V. powered & supply voltage	V	-
Obstruction Light type		Medium Intensity, Type C
Solar powered:		
Number and position of lights per support		As per ICAO
Height and position of work platform		Top crossarm
Height and position of solar array		Earthwire
Diameter of aircraft warning spheres	mm	600
Spacing of aircraft warning spheres	m	30 between adjacent spheres on opposite earthwires

Tower Painting

All towers having more than 60m height above Ground Level (GL) are to be painted, as per the requirements of ICAO.

Annex 15-2: Engineering Documents to be Submitted by Contractor

Clause Reference	Document Description	Comments
15.2.10	Tower painting - painting system	
15.4.1	Obstruction aids - contract drawing	
15.6.2	Painting - method statement	
15.7.1	Test proposals - type, sample, routine	
15.7.2	Galvanizing test results	If requested
15.7.3	Metallic material test certificates	If requested
15.7.3	Bolt and nuts test certificates	If requested
15.7.3	Non-metallic material test certificates	If requested
15.7.3	Type test records	
15.7.3	Sample test records	
15.7.3	Routine test records	If requested
15.7.4	Certificate of conformity	
15.7.5	Commissioning test proposals	
15.7.6	Painting - routine test procedure	

Annex 15-3: Notification and Hold Points

Clause Reference	Notification Points	Hold Points
15.2.10		Tower painting system
15.4.1		Contract drawings
15.6.2		Painting - method statement
15.7.1		Test proposals
15.7.1		Type tests
15.7.5	Commissioning tests	Test proposals
15.7.6		Painting - routine test proposals

Annex 15-4: Reference Standards

The reference standards and other documents referred to in this specification are listed below:

IEC60529:	Classification of degrees of protection provided by enclosures.
BS729:	Specification for hot-dipped galvanising coating on iron and steel articles.
BS1474:	Specification for wrought aluminium and aluminium alloys for general engineering purposes bars, extruded round tubes and sections.
BS1490:	Aluminium and aluminium alloy ingots and castings for general engineering purposes.
BS3463:	Specification for ingot zinc.
BS3643:	ISO Metric threads. Part 2: Limits and tolerances for course pitch series threads.
BS3692:	Specification for ISO Metric Precision hexagon bolts, screws and nuts.
BS4190:	Specification for ISO Metric hexagon bolts, screws and nuts.
BS4320:	Specification for metal washers for general engineering purposes Metric series.
BS4549:	Guide to quality control requirements for reinforced plastic moulding.
Part1:	Polyester resin mouldings reinforced with chopped strand mat or randomly deposited glass fibre.
BS4464:	Specification for Spring washers for general engineering and automobile purposes. Metric Series.
BS5493:	Protective coatings of iron and steel structures.
BSEN485:	Aluminium and aluminium alloys sheet, strip and plate.
BSEN1676:	Aluminium and aluminium alloys - Alloyed ingots for remelting,
BSEN10025:	Specification for hot rolled products of non-alloy structural steels and their technical delivery requirements.
BSEN10210:	Hot finished structural hollow sections of non-alloy and fine grain structural steels.

16. Miscellaneous

16.1 Tools and Appliances

16.1.1 Each tool or appliance shall be clearly marked with its size and/or purpose and is not to be used for erection purposes by the Contractor.

16.1.2 The tools and appliances with the appropriate boxes are to be handed over to the Employer at the Employer's stores depot at the time of arrival at site.

16.1.3The Contractor shall, where required, by the Engineer, provide test certificates and die-stamp or indelible mark on each piece of equipment in an approved manner.

16.1.4 For details of the tools and appliances to be supplied reference should be made to **Annex 16-1.**

Annex 16-1: Tools & Appliances

(a) Sets of temporary earthing equipment shall consist of one, telescopic, Fibre glass rod 3m total length, complete with a screwing head together with 6 PVC covered 8m lengths of 150mm^2 pure aluminium conductor. Each length of conductor shall be equipped with an earth end clamp which shall have a hardened steel threaded point capable of piercing a galvanised or corroded steel surface to provide a good earth connection. In addition an alloy line end clamp shall be provided which shall be spring loaded and capable of being further tightened around a conductor of up to 32.4mm diameter, to provide a good electrical connection. The line end clamp and the screwing head of the pole shall be such that the latter is capable of holding, fixing and tightening the end clamp onto the conductor when attached to the temporary earth lead.

The leads are expected to withstand a fault current of 2.5kA for 10s.

(b) Tower Footing Earth Impedance Measurement Instrument -

The Tower Footing Earth Impedance Measurement Instrument shall be designed to measure impedance, resistance, and inductance of transmission line tower footings without disconnecting the overhead earth wire. The equipment shall operate as per IEEE 81-1983 and IEEE 81-2012 standards. The principle of operation is based on the Fall of Potential (3-point method) using high frequency. The equipment operates at 25 kHz. The output voltage and short-circuit current ratings are 250 kV and 10 mA, respectively. The range of measurement should be 0.01 Ω to 2 kΩ, with an accuracy of ±5%. A high-resolution graphic LCD display shall be integrated into the equipment. For long and continuous operation, a rechargeable battery shall be used. The operating and storage temperatures of the equipment shall range from -10°C to +50°C. An IP67 casing shall be utilized for environmental protection. The equipment shall have a data storage capacity of 300 results and include an option to transfer recorded data to a PC or mobile device with GPS location functionality.

17. Packing, Protection and Despatch Marking

17.1 General

17.1.1. The following minimum packing methods shall be adopted for suppliers external to the country of the transmission line installation, unless otherwise specified.

17.1.2. The Supplier shall be entirely responsible for ensuring that the packing is suitable for transit and storage and will be held responsible for any shortages or damage during transit.

17.1.3. Wherever possible, the Supplier shall utilize shipping by container vessels in the containers of the correct type for the item being shipped to reduce the likelihood of damage to the items. If containerization is not possible the requirements of the following clauses shall be applicable.

17.1.4. All materials shall be carefully packed in a manner suitable for transport to and storage under the climatic conditions present. Items packed in cases or crates shall be so secured that they are not free to move, and cannot work loose in transit.

17.1.5. Wood wool is to be avoided as a packaging material as far as possible.

17.1.6. Waterproof paper and felt lining are to overlap at the seams by at least 12mm, and the seams secured together in an approved manner, but the enclosure is to be provided with vermin proof screened openings to permit ventilation.

17.1.7. A packing note in a weatherproof plastic envelope is to be securely attached to the right hand lower corner of one side of all cases or crates. A copy of the packing list shall also be included inside.

17.1.8. All packing cases or crates shall be marked on the outside to show the correct way up and where relevant, where the weight is bearing and the correct positions for slings.

17.1.9. Shipping mark, numbers and symbols will be provided by the Employer. These marks shall be applied to conductor drums and cases either by the use of a waterproof stencil, flo-pen or any other permanent method. The use of tie-on tags is not permitted. Cases shall be marked on two opposite sides.

All marks shall be clearly legible at the time of dispatch.

17.2 Lattice Tower and Associated Steelwork

(a) Main Legs Steel Poles, Heavy Sections

As loose items, or as below .

(b) Angle Bracings and Large Plates

Bundled in packagesoflessthan5tandstrap-bondedasfollows:

Galvanized -tensional steel stripping, either:

i) Tension strapping 32mm x 0.8mm, minimum of two bands and at maximum centres of 2m; or
ii) Tension strapping 19mm x 0.8mm, minimum of three bands and at maximum centres of 1.25m.

Whichever method i) or ii) is adopted, bundles shall also have a layer of either hessian or polythene between the strap-bands and the galvanized steelwork. One end of the bundle shall also be wired in such a way as to prevent the removal of any single piece.

(c) Plates, Small Items

These shall be cased (maximum net mass 500kg).

Cases shall be of sturdy construction, made from new 25mm thick timber and constructed with annular (rag) nails. They shall have packing pieces on the underside to enable the use of fork- lift trucks.

(d) Bolts

Shall be double bagged and cased as above. A contents list shall be included in each bag. (Cases used both (c) and (d) shall be stored in dry areas both before and after packing.

Where required, materials shall be colour flashed to aid recognition.

17.3 Containerisation

Where materials shipped by the use of containers, a reduced level of packing, is acceptable as follows :

(a) Strap-band centres may be increased to 3m for 32mm x 0.8mm bands and 2.5m for 19mm x 0.8mm bands.
(b) The use of wire through bundle ends is not required.
(c) Cases may be 20mm thick timber.

17.4 Conductor

17.4.1. Conductors shall be supplied on drums of sufficient sturdiness to withstand overseas shipment, and the drums shall be securely battened to prevent damage to the conductor.

17.4.2. All wooden components shall be manufactured from sound defect-free seasoned softwood and suitable for prolonged storage without deterioration. Wood shall be either planed or finely sawn to facilitate accuracy in assembly. The thickness of each ply or component part shall be of reasonable uniformity.

17.4.3. The flanges of drums shall be constructed from two ply of wood laminated in such a manner to be cross-grain to each other. The boards shall be close butted to provide maximum support. Fastenings of the flanges shall be with suitable bright nails with the head countersunk on the inside flange. A flange conductor hole of sufficient diameter for the free passage of the conductor shall be cut in one flange. The exposed end of the conductor shall be protected by a suitable sheet metal plate.

17.4.4. Drainage holes shall be provided through each flange as close as possible to the underside of the barrel lagging. The inner checks of the drum shall be painted with an aluminium flake or bitumen based paint.

17.4.5. The spindle hole shall be round and cut through the centre of the centre board of each flange ply. The spindle holes, of not less than 80mm diameters, shall be reinforced by a 6mm mild steel plate bolted to each flange.

17.4.6. The drum barrel shall be of the segmented type, with supports and cross struts, with a diameter not less than 30 times the conductor diameter. The barrel lagging shall be closely butted and shall provide a smooth external finish to the conductor. The barrel and flanges shall be securely clamped together by not less than six M20 bolts.

17.4.7. The inner end of the conductor shall be brought through the drum flange and secured by staples. The outer end shall also be secured to the inner face of the flange in a similar manner painted with aluminium flake paint.

17.4.8. The outer layer of the conductor on the drum shall be covered by either a layer of sheet plastic or waxed paper secured immediately under the circumferential battens so that it is not in contact with the conductor.

17.4.9. Circumferential battens shall enclose the conductor space completely. They shall fit flush with the outer flanges and shall be securely fixed.

17.4.10. Drums shall be provided with a secure waterproof label displaying the maker's name, type, size and length of conductor on the drum. Drum serial number shall be either chiselled into one drum cheek or impressed onto a secure metallic label. Drums shall be painted on all outer surfaces in finishing colours to the option of the manufacturer.

17.4.11. Drums shall display an arrow and the words "Roll This Way" on each cheek to show the correct direction of rolling.

17.4.12. Steel conductor drums shall be used for any spare conductor supplied and shall comply with the requirements of the American Aluminium Association Standards or other equivalent National Standards.

17.5 Insulators

17.5.1 Insulators shall be crated, each crate shall contain insulators units of the same type. Crates shall be either hexagonal or rectangular cross section.

17.5.2 Crates shall be wooden and close boarded, manufactured from sound seasoned softwood a minimum of 20mm thick. They shall be tensioned strapped at not less than three positions along their length. All crates shall be marked with the batch number and insulator code number.

17.5.3 Special attention shall be paid to ensure that all insulators are complete with their security clip.

17.6 Insulator, Conductor and Ancillary Fittings

Insulator, conductor and ancillary fittings shall be cased as per chapter 17.2(c).

17.7 Cable

17.7.1 Cable shall be supplied on drums of sufficient sturdiness to withstand overseas shipment, and the drums shall be securely battened to prevent damage to the cable.

17.7.2 Steel drums shall be used for cable to be supplied and shall comply with the requirements of this specification or other equivalent National Standards.

17.7.3 Drums shall be provided with a secure waterproof label displaying the maker's name, type, size and length of cable on the drum. Drum serial number shall be either chiselled into one drum flange or impressed onto a secure metallic label. Drums shall be painted on all outer surfaces.

17.7.4 Drums shall display an arrow and the words "Roll This Way" on each flange to show the correct direction of rolling.

17.8 Associated Accessories

17.8.1 Associated accessories shall be cased (maximum net mass 500 kg).

17.8.2 Cases shall be of sturdy construction, made from new 25 mm thick timber and constructed with annular (rag) nails. They shall have packing pieces on the underside to enable the use of fork-lift trucks.

18. Method of Measurement & Payment

18.1 Introduction

18.1.1 General

18.1.1.1. Payment will be made in accordance with the unit prices and total prices set against the items in the Price Schedules as amplified in this section and against the final quantities approved by the Employer. These unit prices and total prices shall include all of the work, temporary and permanent, necessary to comply with the Contract. Where non-quantified unit prices are required in the Bid submission, they shall be so provided. Measurement for the purposes of payment shall where appropriate be made jointly by the representative of the Employer and the Contractor.

18.1.1.2. The Contractor when requested shall attend for purposes of measurement, or otherwise accept measurements made by the Employer alone.

18.1.1.3. Where applicable the Contractor shall indicate on each invoice the identification number of each support to which items in the invoice refer.

18.1.1.4. Unit prices in the Schedule where applicable shall be deemed to include for all work on site irrespective of access conditions, including slope of ground, nature of subsoil, presence of water or other obstacles adjacent to or across the line of the route.

18.1.1.5. The unit prices shall include all incidental expenses which the Contractor or specialist Subcontractor may incur in the preparation and maintenance of access, in the provision of site services and of all transportation for labour whether skilled or unskilled.

18.1.1.6. The unit prices in the schedules shall include all out allowances or other supplementary payment to skilled or unskilled labour, customary, authorised or required by regulations in force at the date of the Bid.

18.1.1.7. The unit prices shall be deemed to include payment to labour, or other expenses incurred for idle time during which work on site is interrupted by weather conditions or flooding by storm overflow or the like.

18.1.1.8. Whilst every assistance will be provided to facilitate line construction activities in sequence in accordance with the Contractor's agreed programme of work, there could be occasions when this may not be possible. No claims for additional costs to the Contractor will be accepted solely for such discontinuity of working.

18.1.1.9. Only those prices shown in the miscellaneous unit prices will be accepted as additional to the ContractpricewheretheuseofsuchunitpricesisauthorisedbytheEmployer.

18.1.2 Not used

18.1.3 Nominated Subcontractor/Supplier (not used)

18.1.4 Specialist Subcontractors (not used)

18.1.5 Quantities

The quantities set out in the schedules are unless otherwise defined estimated quantities of the Works. They are not to be assumed as the actual and correct quantities to be executed by the Contractor in fulfilment of his obligations under the contract. The Contractor is presumed to have satisfied himself as to the relevance of the estimated quantities in the preparation of his Bid.

Final quantities shall be established and agreed upon between the Employer and Contractor immediately after the signing of the contract.

18.1.6 CIF/CIP Price

The term CIF/CIP shall be governed by the rules prescribed in the Incoterms of current edition published by the International Chamber of Commerce, Paris.

18.1.7 Freight and Insurance Prices (not used)

18.1.8 Ex-works (EXW) Price

The term EXW shall be governed by the rules prescribed in the Incoterms of current edition published by the International Chamber of Commerce, Paris.

18.1.9 Local Transportation & Erection Price (not used)

18.1.10 Drawings, Reference Standards and Records

The provision of all drawings, design calculations, records etc. as specified in the Contract shall deemed to be included in the contract price.

18.1.11 Test of Major Items for Quality Control

a. Proto-assembly test of towers: Two Engineers of the Employer shall visit at manufacturer's works/ testing station premises before starting the batch manufacturing of towers.

b. Proto type load test of towers: Not applicable.

c. Factory acceptance test (sample test) of towers: Following acceptance test of tower materials shall be done: sample tests of tower materials (visual check, galvanizing test and mechanical test of members/nuts & bolts/plates as specified in the specification) prior to each shipment of materials.

d. Factory Acceptance Test (Sample Test) of Insulators, Conductor, insulator & conductor fittings with accessories, OPGW & OPGW fittings with accessories before each shipment of materials and type test of insulator strings (if applicable): Sample Test of Insulators, Conductor, insulator & conductor fittings with accessories, OPGW & OPGW fittings with accessories shall be done before each shipment of materials.

18.1.12 Instruction of Employer's Staff

18.1.12.1 Overseas Training – Not Applicable

18.1.12.2 Training within Employer's Country – Not Applicable

18.2 Survey

Full precision profile survey undertaken by the Contractor on the Employer's instruction shall be paid for as per unit prices in the Price Schedule and shall be measured to the nearest metre along the centre-line of the route. The unit price shall include for the establishment or re-establishment of the line route from terminal points and other such fixed points the Employer may define, full ground survey, preparation and submission of route maps, Mouza maps, profile drawings with tower plotting, SIMMs document, tree marking and tree schedule and pegging of tower locations. During check survey, the route might need to be changed due to field requirements. Cost involved in such changes shall deemed to be included in the price indicated in the price Schedule. Payment shall be done considering the final length of the line route.

18.3 Route Clearance & Access

Route clearance undertaken by the Contractor on the Employer's instruction shall be paid for at Schedule B unit prices and shall be measured to the nearest metre along the centre line of the route. The prices of route clearance shall include payment of compensation for crops, trees, houses, etc. and all kinds of damage compensation.

18.4 Foundations

18.4.1 General

18.4.1.1. The prices quoted in Price Schedule for the supply and installation of a foundation refers to a foundation required in accordance with the Specification and 'Method of Measurement and payment'. Where additional work is required over and above that provided for in the Specification and 'Method of measurement and Payment' this will be paid on a measured basis at miscellaneous unit prices or unit prices to be agreed.

18.4.1.2. The unit prices for foundations shall include all necessary geotechnical investigation and geotechnical studies as defined in the Specification or as required by relevant authorities.

18.4.1.3. The unit prices for all foundations shall include for site clearing, excavating in any material and by any means, manual or mechanical, and for ensuring, stability and natural drainage inside the working area, for all back filling, compacting and disposal of surplus material, routine testing, site restoration and for all necessary supports to sides of excavations.

18.4.1.4. The complete foundations for a tower shall be paid for at the appropriate Price Schedule unit prices.

18.4.1.5. The unit price shall include for all excavations, conventional pumping (including well-point de- watering), excavation supports, concrete work, formwork. reinforcing, stub steelwork, stub cutting, routine testing, backfilling, clearing up and all other work required to complete the foundation in accordance with the Specification.

18.4.1.6. The unit prices shall also include supply of weak-mix concrete or the importation of any back fill material necessary due to the excavated material being unsuitable as backfill.

18.4.1.7. The unit prices for foundations shall include the use of whichever type of cement is to he used and density of concrete necessary to meet the requirements of the Specification.

18.4.1.8. The unit prices for foundations shall include all stub steelwork installation and setting out including the use of templates, setting to any level and any excavation necessary for Setting out. The protective treatment to defined concrete faces or support steelwork and provision of site protection barriers shall be included in the rates for the foundations.

18.4.1.9. The unit prices for foundations shall include the cost for all earthing requirements.

18.4.1.10. Where site stabilization outside the defined 'working area' is required this shall be undertaken at unit prices to be agreed.

18.4.1.11. Design tests on foundations to prove the foundation design shall be paid for at the unit prices quoted. The unit prices shall include for the removal of concrete and steel down to 1m below ground level where this is deemed necessary by the Employer.

18.4.1.12. All costs regarding making necessary arrangement for de-watering or whatsoever required starting the foundation inside river or water logged locations shall be included in the unit price of foundation.

18.4.2 Piled Foundations and Special Foundations

The complete foundations for each support shall be paid for at the appropriate Schedule B unit prices. The unit prices shall include for mobilization and de-mobilization of piling rig, setting out, cleaning, cutting, to length, reinforcement and pile cap connection, jointing of piles as necessary irrespective of number of piles, all excavations (including rock), conventional pumping (including well-point de-watering), excavation supports (including use of bentonite slurries), concrete work for piles, pile cap and tie beams, formwork, reinforcing stub steelwork, stub cutting, routine testing, backfilling, clearing up and all other work required to complete the foundation in accordance with the Specification.

The unit prices for piled foundations shall be based on the unit price for a complete tower foundation including piles, pile cap and tie beams etc..

18.4.3 Flood Protection Walls (not used)

18.4.4 Miscellaneous Unit Prices

The miscellaneous unit price for additional excavation shall include for site clearing, excavating in any material and by any means manual or mechanical and for ensuring, stability and natural drainage, pumping, backfilling, compacting and disposal of surplus material, site restoration and for all necessary support to the sides of the excavation.

The miscellaneous unit price for additional concrete shall include for all design and preparation formwork and all other work necessary.

The miscellaneous unit price for reinforcement shall include for design and drawing preparation of bar bending schedules, cutting, bending, fixing and all other associated activities.

18.5 Steel Towers

18.5.1. Steel towers normal extensions shall be paid for at Schedule B unit prices. The unit prices shall include for standard crossarms and shall include stub steelwork.

18.5.2. The unit prices for steel towers shall include for access facilities, anti-climbing devices, attachment plates, ancillary steelwork etc. used as standard fittings on the tower.

18.5.3. The unit prices shall include for all tower mounted notice plates.

18.5.4. Type tests, including prototype tests (if required by this specification), which shall be conducted at an independent testing facility or manufacturer's own testing facility on the specified Contractor-designed lattice steel towers, shall be paid for at the unit prices quoted in Schedule B, but only if the test proves that the Contractor-designed tower complies with the requirements of the specification (see Tower Section).

18.5.5. Special Supports and additional steelwork to the approved design shall be paid for at Schedule B unit prices.

18.5.6. The unit price of towers shall include all supplies and all works associated with the towers which are specified in this bid document.

18.5.7. The painting of towers in accordance to ICAO regulations painting of bottom parts of towers in flooding areas shall be paid based on unit prices, which include supply of materials and the specific works.

18.6 Insulator Sets and Associated Fittings

18.6.1 All Insulator sets shall be paid for at Schedule B unit prices. The unit prices for insulator, sets shall include for all insulator units, links, sag adjusters, turnbuckles, weights, insulators protective devices (arc horns), tension joints (dead ends) and suspension clamps (Inclusive of helical armour rods), used as a standard between the support and the phase conductor and all others fittings specified to be supplied in this tender document.

18.6.2 Unit prices for earthwire tension and suspension sets shall where specified include for all earthwire bonding to the supports including all earthwire bonding clamps in accordance with the Specification and all others fittings specified to be supplied in this tender document.

18.6.3 All conductor tee-connectors and line termination fittings shall be paid for at Schedule B unit prices.

18.7 Conductor and Fittings

18.7.1. Phase conductors and earthwires including OPGW shall be paid for at Schedule B unit prices, and shall be measured to the nearest meter after erection, along the centre of the route without allowance for sag jumpers or scrap. The supply and erection unit price shall include for all normal phase and earthwire jumpers including the jumpers at terminal supports between phase conductors or earthwires and downleads.

18.7.2. Downleads between terminal supports and anchorages and down droppers between downleads and substation equipment shall be paid for at Schedule B unit prices. The unit prices shall include for conductors, jumpers and associated fittings.

18.7.3. The cost of fibre optic earthwire (OPGW) connections to the joint boxes, fixing clamps, joint boxes and fusion splicing of optical fibres shall be included in the erection unit price of OPGW.

18.7.4. The aforementioned erection unit prices shall include all joints, clamps and fittings other than insulator sets and their fittings, tension joints (dead ends) and/or earthwire, jumpers and downlead conductors.

18.7.5. All spacer dampers, vibration dampers and spacers including bonding and weighted jumper and/or spacer shall be paid for at Schedule B unit prices.

18.8 Aircraft Navigation (Obstruction Aids)

The unit price shall include for the warning lights and as appropriate connection to the LV mains supply or solar panels, storage batteries etc., all power and control cables, solar light switches, support steel works as necessary.

18.9 Cables and Fittings

The power cables and optical fibre cables shall be paid for at the Schedule of Rates and Prices, and shall be measured to the actual length installed after completion of installation and jointing.

The cost of the joint boxes of optical fibres shall be included in the supply unit price of Optical fiber cable.

18.10 Miscellaneous

Tools and spares shall be paid for at the Schedule B unit prices.

18.11 Payment for Work Carried out at Time and Material Rates

18.10.1. The Employer may, if in their opinion it is necessary or desirable, order that any additional or substituted work shall be executed on a Time and Material basis.

18.10.2. No work shall be carried out on a Time and Materials basis without written instructions of the Employer. All applications for payment for such work by the Contractor shall be accompanied by statements, authorizing the undertaking of such work, duly signed by the Employer and shall be submitted within three months of completion of such work.

18.10.3. When the work is in progress the Contractor shall render day work sheets in duplicate to the Employer showing the number of men so employed with the number of hours worked and detailed quantities of materials used. The Contractor shall obtain the Employer's certification of the day work sheets at the end of each working week whilst the work is in progress and failure to do so shall render the Contractor liable to forfeiture of payment.

18.10.4. Where the Contractor is required to carry out work at the Time and Material unit prices, the Employer will furnish the Contractor with such particulars as necessary to enable the Contractor to prepare such drawings and schedules as required for such work. Unit prices for work executed on a Time and Material basis shall be agreed.

19. Erection / Installation of Overhead transmission lines in the areas exposed to electric field

19.1 Introduction

19.1.1. The erection / installation of overhead transmission lines near the energized overhead lines will strictly observe the provisions of IEEE STD 524 - 2003 "IEEE Guide to the Installation of "Overhead Transmission Line", as follows:

- Chapter 5 - Grounding equipment and method;
- Chapter 10 - Typical procedures for stringing operations, paragraph:
  - 10.3.2 Equipment
  - 10.3.3Bonding and grounding of conductor end
  - 10.6 Dead-ending precautions

19.1.2. Voltage sensors will be compulsory provided for the teams working in areas exposed to electrical field.

19.1.3. Where a new overhead line is being installed adjacent to, or parallel with an existing energized transmission line all tools and machinery (trucks, cranes etc.) will be placed in such a way that during the work to keep a minimum distance to the under tension elements as follows (protection area):

- 2.0 m for overhead lines 0.4 … 20 kV;
- 3.0 m for overhead lines 132 kV;
- 4.0 m for overhead lines 230 kV;
- 5.0 m for overhead lines 400 kV.

19.1.4. Pegs / and strips will mark the protection areas Also, all machinery will be grounded by copper conductors (S ≥ 16 mm^2) to the tower earthing or to provisional earthing made by metallic rods.

19.2 Foundation Installation

All cranes and other machineries used for digging, concrete casting, compacting etc. will be provided with devices for voltage presence signalization. Also will be grounded to the earthing systems as shown above.

19.3 Gin Pole Erection

19.3.1The gin pole erection could be done with the inductive overhead line energized if the distance between the limit of protection area and the nearest leg of tower, which will be erected, is bigger than tower and gin pole height.

19.3.2Also before the starting of base trunk erection the main members have to be grounded to an earthing system

19.3.3Ropes to avoid any casual breaking of detachment will securely bond the gin pole anchors. All machineries used for gin pole erection will be grounded as shown above.

19.4 Crane Erection

The crane erection could be done with the inductive overhead line energized whether the distance between the limit of protection area and the nearest leg of tower is bigger than the total length of telescoping boom and the length of the last trunk (generally earth wire peak).

19.5 Conductor Stringing

19.5.1. Generally, the following operations could be carried out with the parallel inductive overhead line energized:

- Transport of materials (conductors, insulators, hardware);
- The insulator string assembling near the tower location;
- Drums preparations for stringing;
- Conductor clipping;
- Jumper installation.

19.5.2. All other operations regarding the conductor stringing have to be done with the inductive overhead line de-energized, except the following situation.

19.5.3. Whether the maximum values of touch voltage and step voltage calculated by Contractor are less than permissible values stated in his conductor stringing methodology, could be carried out the following operations:

- conductor stringing;
- mounting of the dampers, spacers and spacer dampers, warning spheres.

19.5.4. Conductor stringing precautions:

- The rolling blocks will be without neoprene and grounded, to an earthing system by flexible copper conductor ($S \geq 16$ mm²);
- The machineries used (bull wheel puller, bull well puller, drum puller, tractors etc.) will be grounded in same way;
- The jumpers between sections will be grounded also to the earthing system;
- During stringing the conductors will be securely bonded by non-metallic ropes to avoid uncontrolled movements.

19.5.5. Conductor clipping mounting of the dampers, spacers and spacer dampers, warning spheres precautions.

19.5.6. Before starting the work will be established the "protection work zone".
19.5.7. For suspension towers, the protected work zone will be marked by two flexible copper conductors (S ≥ 16 mm²) mounted each side of rolling block.

19.5.8. For angle towers, the same conductors fixed near the dead-end clamps will mark the protected work zone.

19.5.9. The installation of conductors for overhead lines in parallel with other energized overhead lines is forbidden in bad weather conditions (rain, wind, fog, lightning).

19.6 Second Circuit Installing

19.6.1 In case of installing the second circuit of an old line, before starting the works,

- The towers and foundations shall be checked mechanically for supporting the second circuit in all design cases
- All towers shall be inspected and where angles and/or bolts are missing, new elements shall be installed

19.6.2 The IEEE provisions and tool and machineries described in clause 19.1 shall be observed.

19.6.3 The conductor stringing shall be in accordance to operations and restrictions described in clause 19.5.

19.6.4 Before starting the works the Contractor shall send for approval his conductor stringing methodology.

19.6.5 For details of the equipment and works reference should be made to **Annex 19-1**.

Annex 19-1: Requirements for Stringing the Second Circuit

- Not applicable

20. Test on Completion

20.1 Final Construction Check

20.1.1. Before completion of transmission lines, the Contractor shall submit final check erection documentation for approval

20.1.2. Subsequent to the completion of the transmission line construction, the Contractor shall carry out final checking and testing works and shall supply:

a. tools, appliances and spare materials required for maintenance of the transmission lines and
b. all outstanding drawings and documentation to be provided under the contract.

20.1.3. The final construction check shall include but not be limited to:

- tighten bolts and fix missing members to towers;
- remove all scaffolds and equipment and clear all debris and other rubbish from the site;
- restore surface damage, foundation subsidence and carry out erosion control measures, where directed by the Employer's Representative or as required by local authorities or regulations;
- remove of all left-over materials at winch yards, drum yards and store yards;
- complete danger tree cleaning and tree re-cleaning and the right-of-way

20.2 Test on Completion

20.2.1 Pre-Commissioning Testing

20.2.1.1 Pre-commissioning Line Testing

As preamble, the civil work tests will be performed prior to approval tower erection and tower erection tests and tower earthing system resistances will be performed prior conductor stringing, it means before entering into the next hierarchy, successful completion of preceding tests has to be certified for each functional group of equipment. The recording documents shall be attached to the line manual.

20.2.1.2 Pre-Commissioning Optical Link Testing

Before completion, the optical performance of the OPGW and ADSS and if applicable OPUG cable installation shall be carried out progressively as each joint is installed, to ensure that the losses for each individual component and the complete installation are within the required values.

The following attenuation tests shall be carried out using methods approved and witnessed by the Employer's Representative:

- OTDR tests of delivered cable lengths - All fibres of each OPGW drum shall be tested from both ends of the drum at wavelengths of 1550 nm. The measured attenuation shall not exceed the specified maximum values;

- OTDR tests of completed joints - Tests at wavelengths of 1550 nm shall be carried out on each fibre from both ends of the jointed OPGW as each joint is installed. The average attenuation of each joint determined from the progressive measurements from each end shall not exceed the specified maximum values for each optical fibre.

20.2.1.3 Line Parameter Measurement

Before charging the line, the contractor shall measure all the line parameters accurately and submit to the employer using their owned or rented equipment.

20.2.2 Commissioning Testing

20.2.2.1 Commissioning Line Testing

Prior to the handover of the completed line, the following tests shall be carried out:

- conductor electrical continuity tests for each phase, using telephone signals or an alternative method approved and witnessed by the Employer's Representative;
- insulation megger tests for each phase, witnessed by the Employer's Representative;
- tower earthing system electrical resistance measurements by means of a high frequency instrument arranged by the Contractor and approved by the Employer's Representative.

20.2.2.2 Commissioning Optical Links Testing

Commissioning optical links testing refers to OTDR tests of complete OPGW installation.

The average of the attenuation measurements from each end of the fully installed OPGW shall not exceed the maximum value calculated according to the number of components installed, for each optical fibre, between the Optical Distribution Frames installed in Substations.

$$[(L_{line} + L_{ADSS} + L_{OPUG}) \times 0.25 + N_{joint\ box} \times 0.06 + 2 \times 0.15\ _{attenuation\ of\ Patch\ Chords}]$$

20.2.3 Safety Measures after Final Checking

On completion of the final checking and testing, the Contractor shall deliver to the Employer /Employer's Representative a written statement certifying that the line is complete in every respect and that all earths placed by the Contractor have been removed and that every member of the Contractor's staff has been informed that he must not work on the line again unless in possession of an authority signed by the Employer's Representative.

20.2.4 Line Thermographic Analysis by Helicopter / Drone (Hot-Spot)

During the defects liability period, the Employer will perform and check the line for hot spots. All hot spots found, including local damages, shall be remedied by the Contractor on his own costs.

20.2.5 Maintenance during Liability Period, prior to Final Taking-Over

The Contractor shall ensure the integrity of the line components on the line and waiting for the final checking and testing.

This applies especially to insulators, towers (for small damages), soil erosion around foundations and vegetation re-clearing

The costs of the line maintenance prior final taking-over shall be borne by the Contractor.

21. Painting of Bottom Parts of Towers

21.1. All tower steelwork upto minimum height of 3m above ground level shall be protected by coal tar epoxy coatings.

21.2. In some areas where the tower may be under water during the rainy season, the tower (All members) shall be painted for navigation with reflecting paint up to 3 m above epoxy coat. The Contractor has to submit the details specification of the reflecting paint and the location nos. of the towers which shall be painted, to the Employer's engineer for approval before start of the painting.

21.3. All painting shall be done in fine weather and surfaces must be dry before commencement of each coat.

21.4. Details of the paint, Manufacturer, surface preparation and method of application shall be submitted for Employer's Representative's approval prior to commencement of painting.

21.5. Before application of coal tar epoxy, galvanized steel members shall be lightly grit blasted (i.e. one pass of the grit blast nozzle at a distance of approximately 600 mm from the surface) to provide a suitable profile for adhesion of the coating.

21.6. Within four hours of blasting the first coat of coal tar epoxy shall be spray applied to the clean, dry steel to give a dry film thickness of not less than 150 microns. The coating shall be checked for thickness using a magnetic coating thickness gauge and for pinholes using a spark tester. Any deficiencies shall be repaired immediately.

21.7. A second coat of coal tar epoxy shall be applied after a minimum of four hours after the application of the first coat but not later than five days after the application of the first coat to give a total dry film thickness of not less than 300 microns. Coal tar epoxy shall not be applied when relative humidity exceeds 85%.

21.8. For site application the same procedure shall be adopted except that use of an 'etch primer' instead of blast cleaning on site will be permitted. The 'etch primer' must be obtained from the same supplier as the coating and applied strictly in accordance with the manufacturer's instructions including the cleaning and decreasing of the tower steelwork on site.

22. Bid Drawings

22.1 The following drawings are enclosed for tender purposes

Item	Drawing Number	Title
22.1.1	**Drawings for 132kV Transmission Line**	
(a)	**Hardware Fittings**	
(i)	PGCB/132kV/SS	Suspension set for conductor
(ii)	PGCB/132kV/HS	Heavy suspension set for conductor
(iii)	PGCB/132kV/TS	Tension set for conductor
(iv)	PGCB/132kV/ULD	Upright low duty tension set
(v)	PGCB/132kV/ILD	Inverted low duty tension set
(vi)	PGCB/132kV/OPGW/SS	OPGW suspension set
(vii)	PGCB/132kV/OPGW/TS	OPGW tension set
22.1.2	**Drawings for 230kV Transmission Line – Not applicable**	
(a)	**Hardware Fittings**	
(i)	PGCB/230KV/SS	230 kV suspension set for twin conductors
(ii)	PGCB/230KV/TS	230 kV tension set for twin conductors
(iii)	PGCB/230KV/ULD	230 kV upright low duty tension set for twin conductors
(iv)	PGCB/230KV/EW/SS	Earthwire suspension set
(v)	PGCB/230KV/EW/TS	Earthwire tension set
(vi)	PGCB/230KV/OPGW/SS	OPGW suspension set
(vi)	PGCB/230KV/OPGW/TS	OPGW tension set
22.1.3	**Drawings for 400kV Transmission Line– Not applicable**	
(a)	**Hardware Fittings**	
(i)	PGCB/400KV/SS	Suspension set for conductor
(ii)	PGCB/400KV/HS	Heavy suspension set for conductor
(iii)	PGCB/400KV/TS	Tension set for conductor
(iv)	PGCB/400KV/ULD	Upright low duty tension set

Item	Drawing Number	Title
(v)	PGCB/400KV/ILD	Inverted low duty tension set
(vi)	PGCB/400KV/OPGW/SS	OPGW suspension set
(vii)	PGCB/400KV/OPGW/TS	OPGW tension set
(viii)	PGCB/400KV/EW/SS	Earthwire suspension set
(ix)	PGCB/400KV/EW/TS	Earthwire tension set
(x)	PGCB/400KV/RC/SS	River Crossing suspension set for conductor
(xi)	PGCB/400KV/RC/TS	River Crossing tension set for conductor
22.1.4	**Other Drawings**	
(i)	PGCB/TL/INS	Typical drawing for insulator showing zinc sleeve & straight head
(ii)	PGCB/TL/EARTHWIRE, Rev.1	Earthing arrangement
(iii)	PGCB/DC/DP	Danger plate for double circuit towers
(iv)	PGCB/NP	Number plate
(v)	PGCB/SB	Step bolt

22.2 The following drawings are included in the CD. These drawings are already approved and to be considered part of this bidding document

Item	Drawing Number	Title
(1)	**Towers**	
1.1	**132kV Double Circuit Towers**	
(a)	Tower type 1DL Narrow base	
(i)	T2005-1DL-01, Rev-A	132kV Tower Type - 1DL, Top Part
(ii)	T2005-1DL-02, Rev-B	132kV Tower Type - 1DL, Bottom Part
(iii)	T2005-1DL-03, Rev-B	132kV Tower Type - 1DL, E+0 Body Extension
(iv)	T2005-1DL-04, Rev-B	132kV Tower Type - 1DL, E1.5 Body Extension
(v)	T2005-1DL-05, Rev-B	132kV Tower Type - 1DL, E3 Body Extension
(vi)	T2005-1DL-06, Rev-B	132kV Tower Type - 1DL, E4.5 Body Extension
(vii)	T2005-1DL-07, Rev-B	132kV Tower Type - 1DL, E6 Body Extension

Item	Drawing Number	Title
(viii)	T2005-1DL-08, Rev-B	132kV Tower Type - 1DL, E9 Body Extension
(ix)	C870/1DL/STUB-01, Rev-0	132kV Tower Type - 1DL, Detail Drawing of Stub & Cleat for Body Ext. +0M, +1.5M, +3M, +4.5M, +6M & +9M
(x)	C870/1DL/STUB-02, Rev-3	132kV Tower Type - 1DL, Detail Drawing of Stub & Cleat for Body Ext. +0M, +1.5M, +3M, +4.5M, +6M & +9M WITH +2.0M Raised Chimney
(xi)	T2005-1DL-10, Rev-A	132kV Tower Type - 1DL, Adjustment Template
(b)	Tower type 1D1 Narrow base	
(i)	T2005-1D1-01, Rev-B	132kV Tower Type - 1D1, Top Part
(ii)	T2005-1D1-02, Rev-A	132kV Tower Type - 1D1, Bottom Part
(iii)	T2005-1D1-03, Rev-B	132kV Tower Type - 1D1, E+0 Body Extension
(iv)	T2005-1D1-04, Rev-B	132kV Tower Type - 1D1, E1.5 Body Extension
(v)	T2005-1D1-05, Rev-B	132kV Tower Type - 1D1, E3 Body Extension
(vi)	T2005-1D1-06, Rev-B	132kV Tower Type - 1D1, E4.5 Body Extension
(vii)	T2005-1D1-07, Rev-B	132kV Tower Type - 1D1, E6 Body Extension
(viii)	T2005-1D1-08, Rev-B	132kV Tower Type - 1D1, E9 Body Extension
(ix)	T2005-1D1-11, Rev-0	132kV Tower Type - 1D1, E12 Body Extension
(x)	C870/1D1/STUB-01, Rev-0	132kV Tower Type - 1D1, Detail Drawing of Stub & Cleat for Body Ext. +0M, +1.5M, +3M, +4.5M, +6M, +9M
(xi)	C870/1D1/STUB-02, Rev-0	132kV Tower Type - 1D1, Detail Drawing of Stub & Cleat for Body Ext. +12M
(xii)	TC529/1D1/STUB-01A, Rev-0	Detail Drawing of Stub & Cleat for Tower Type 1D1 for Body Ext. +0M, +1.5M, +3M, +4.5M, +6M, +9M with +1m Raised Chimney
(xiii)	TC529/1D1/STUB-02A, Rev-0	132kV Tower Type - 1D1, Detail Drawing of Stub & Cleat for Body Ext. +12M with +1m Raised Chimney
(xiv)	Detail Drawing of Stub & Cleat for Tower Type 1D1 for Body Ext. +0M, +1.5M, +3M, +4.5M, +6M, +9M with +2m Raised Chimney, Rev 01	Detail Drawing of Stub & Cleat for Tower Type 1D1 for Body Ext. +0M, +1.5M, +3M, +4.5M, +6M, +9M with +2m Raised Chimney
(xv)	132kV Tower Type - 1D1, Detail Drawing of Stub & Cleat for Body Ext. +12M with +2m Raised Chimney, Rev 01	132kV Tower Type - 1D1, Detail Drawing of Stub & Cleat for Body Ext. +12M with +2m Raised Chimney
(xvi)	T2005-1D1-10, Rev-A	132kV Tower Type - 1D1, Adjustment Template
(c)	Tower type 1D25 Narrow base	
(i)	T2005-1D25-01, Rev-B	132kV Tower Type - 1D25, Top Part
(ii)	T2005-1D25-02, Rev-B	132kV Tower Type - 1D25, Bottom Part
(iii)	T2005-1D25-03, Rev-A	132kV Tower Type - 1D25, E+0 Body Extension
(iv)	T2005-1D25-04, Rev-A	132kV Tower Type - 1D25, E1.5 Body Extension
(v)	T2005-1D25-05, Rev-C	132kV Tower Type - 1D25, E3 Body Extension
(vi)	T2005-1D25-05A, Rev-0	132kV Tower Type - 1D25, E9 Body Extension
(vii)	C870/1D25/STUB-01, Rev-0	132kV Tower Type - "1D25", Detail Drawing of Stub & Cleat for Body Ext.+0M, +1.5M & +3M
(viii)	C870/1D25/STUB-02, Rev-0	132kV Tower Type - "1D25", Detail Drawing of Stub & Cleat for Body Ext.+6M & +9M
(ix)	TC529/1D25/STUB-02C,	Detail Drawing of Stub & Cleat for Tower Type 1D25 for Body Ext.+6M

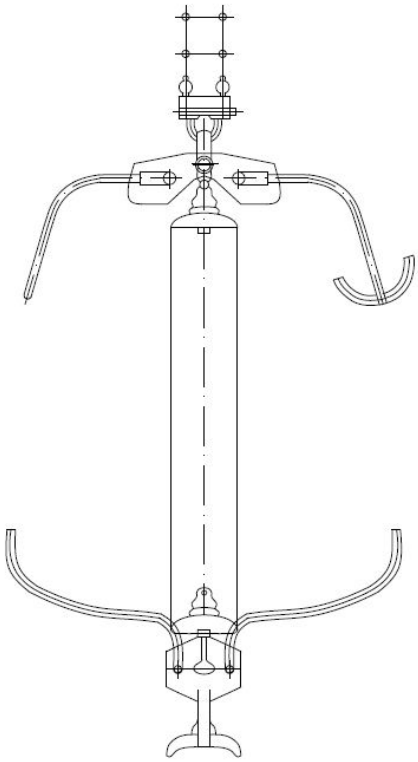
Item	Drawing Number	Title
	Rev-0	& +9M with +1m Raised Chimney
(x)	C870/1D25/STUB-03, Rev-0	132kV Tower Type - "1D25", Detail Drawing of Stub & Cleat for Body Ext.+0M, +1.5M & +3M WITH +2.0M Raised Chimney
(xi)	C870/1D25/STUB-02, Rev-0	132kV Tower Type - "1D25", Detail Drawing of Stub & Cleat for Body Ext. +6M & +9M WITH +2.0M Raised Chimney
(xii)	T2005-1D25-07, Rev-0	132kV Tower Type - 1D25, Adjustment Template
(xiii)	T2005-1D25-08, Rev-0	132kV Tower Type - 1D25, E9 Body Ext. Template
(a)	Tower type 1DT6 Narrow base	
(i)	T2005-1DT6-01, Rev. 0	132kV Tower Type – 1DT6, Top Part
(ii)	T2005-1DT6-02, Rev. 0	132kV Tower Type – 1DT6, Bottom Part
(iii)	T2005-1DT6-03, Rev. 0	132kV Tower Type – 1DT6, E0 Body
(iv)	T2005-1DT6-04, Rev. 0	132kV Tower Type – 1DT6, E1.5 Body
(v)	T2005-1DT6-05, Rev. 0	132kV Tower Type – 1DT6, E3 Body
(vi)	T2005-1DT6-06, Rev. 0	132kV Tower Type – 1DT6, E4.5 Body
(vii)	T2005-1DT6-07, Rev. 0	132kV Tower Type – 1DT6, E6 Body
(viii)	T2005-1DT6-08, Rev. 0	132kV Tower Type – 1DT6, E9 Body
(ix)	T2005-1DT6-09, Rev. 0	132kV Tower Type – 1DT6, Stub
(x)	C870/1DT6/STUB-01, Rev-0	Detail Drawing of Stub & Cleat for Tower Type 1DT6 for Body Ext. +0M, +1.5M, +3M, +4.5M, +6M, +9M
(xi)	TC529/1DT6/STUB-01A, Rev-0	Detail Drawing of Stub & Cleat for Tower Type 1DT6 for Body Ext. +0M, +1.5M, +3M, +4.5M, +6M, +9M with +1m Raised Chimney
(xii)	C870/1DT6/STUB-02, Rev-0	Detail Drawing of Stub & Cleat for Tower Type 1DT6 for Body Ext. +0M, +1.5M, +3M, +4.5M, +6M, +9M with +2.0m Raised Chimney
1.2	**132kV Four Circuit Towers**	
(a)	Tower type 1QL	
(i)	DS-1607, Sheet 1 of 1	Outline diagram for 132kV M/C tangent tower (1QL)
(ii)	S-2288, sheet 1 of 1, Rev. 3	Structural drawing of Peak, Top X-Arm & X-Arm-4 & 3 of 1QL type tower
(iii)	S-2289, sheet 1 of 1, Rev. 3	X-Arm-1 & X-Arm-2 and bottom x-arm
(iv)	S-2290, sheet 1 of 1, Rev. 1	Cage-I
(v)	S-2291, sheet 1 of 1, Rev. 0	Cage-II
(vi)	S-2292, sheet 1 of 1, Rev. 0	Body-I
(vii)	S-2293, sheet 1 of 1, Rev. 0	Body-II
(viii)	S-2294, sheet 1 of 1, Rev. 0	+0m Extension and plan at 'B-B'
(ix)	S-2295, sheet 1 of 1, Rev. 0	+9m Extension
(x)	S-2296, sheet 1 of 1, Rev. 1	+0m Extension (view at 'F' and plan at 'A-A'
(xi)	S-2407, sheet 1 of 1, Rev. A	+1.5m Extension
(xii)	S-2408, sheet 1 of 1, Rev. 0	+3m Extension
(xiii)	S-2409, sheet 1 of 1, Rev. 0	+4.5m Extension
(xiv)	S-2410, sheet 1 of 1, Rev. 0	+6m Extension
(xv)	PGCB/GtoG/01/1QL/SD/01, Rev. 1	Detail Drawing of Stub & Cleat for Tower Type 1QL
(xvi)	PGCB/Kfw-2.2/1QL/SD/01, Rev. 0	Detail Drawing of Stub & Cleat with 2m Raised Chimney for Tower Type 1QL
(xvii)	A-5441, sheet 1 of 1,	General arrangement of ACD for all four circuit towers

Item	Drawing Number	Title
**(xviii)	PGCB/132kV/WB-P1/SP/ 1QL/01, Sheet 1 of 1, Rev. 0	Structural Drawing for Single Peak of Tower Type 1QL
(b)	Tower type 1Q15	
(i)	DS-1674, Rev. E, Sheet 1 of 1	Outline diagram for 132kV M/C tension tower (1Q15)
(ii)	S-2310, sheet 1 of 1, Rev. D	Structural drawing of GW X-Arm & X-Arm-5 & 6 of 1Q15 type tower
(iii)	S-2311, sheet 1 of 1, Rev. C	X-Arm-3 & X-Arm-4
(iv)	S-2312, sheet 1 of 1, Rev. D	X-Arm-1 & X-Arm-2
(v)	S-2313, sheet 1 of 1, Rev. E	Cage-I
(vi)	S-2314, sheet 1 of 1, Rev. E	Cage-II
(vii)	S-2315, sheet 1 of 1, Rev. D	Body
(viii)	S-2316, sheet 1 of 1, Rev. D	Basic body with plan 'B-B'
(ix)	S-2317, sheet 1 of 1, Rev. D	0-Base
(x)	S-2318, sheet 1 of 1, Rev. D	+6m Extension (top part of +12m & +15m Extension)
(xi)	S-2319, sheet 1 of 1, Rev. D	Plan view 'A-A' & Oblique view 'D'
(xii)	S-2320, sheet 1 of 1, Rev. D	+15m Extension
(xiii)	S-2321, sheet 1 of 1, Rev. D	Plan view 'C-C' & Oblique view 'H'
(xiv)	S-2441, sheet 1 of 1	+1.5m Extension
(xv)	S-2442, sheet 1 of 1, Rev. A	+3m Extension
(xvi)	S-2443, sheet 1 of 1, Rev. A	+4.5m Extension
(xvii)	S-2444, sheet 1 of 1, Rev. A	+9m Extension
(xviii)	S-2445, sheet 1 of 1, Rev. A	+6m Extension (bottom part of +12m)
(xix)	PGCB/GtoG/01/1Q15/SD/01, Rev. 1	Detail Drawing of Stub & Cleat for Tower Type 1Q15
**(xx)	Ghatl-RPCL/132kV/TL/TLD, Sheet 1 of 2, Rev. 0	Structural Drawing of Single Peak of Tower Type 1Q15
**(xxi)	Ghatl-RPCL/132kV/TL/TLD, Sheet 2 of 2, Rev. 0	Structural Drawing of Single Peak of Tower Type 1Q15
(c)	Tower type 1Q30	
(i)	DS-1716, Rev. A, Sheet 1 of 1	Outline diagram for 132kV M/C tension tower (1Q30)
(ii)	S-2336, sheet 1 of 1, Rev. B	GW X-Arm & X-Arm-5 & 6
(iii)	S-2337, sheet 1 of 1, Rev. B	X-Arm-3 & X-Arm-4
(iv)	S-2338, sheet 1 of 1, Rev. B	X-Arm-1 & X-Arm-2
(v)	S-2339, sheet 1 of 1, Rev. B	Cage-I
(vi)	S-2340, sheet 1 of 1, Rev. B	Cage-II
(vii)	S-2341, sheet 1 of 1, Rev. A	Body
(viii)	S-2342, sheet 1 of 1, Rev. A	Basic body
(ix)	S-2343, sheet 1 of 1, Rev. B	Plan view "B-B" and oblique view "J & K"
(x)	S-2344, sheet 1 of 1, Rev. A	± 0 Base
(xi)	S-2345, sheet 1 of 1, Rev. A	+3m Extension with plan view "A-A" and oblique view "C"
(xii)	S-2346, sheet 1 of 1, Rev. A	+4.5m Extension with oblique view "D"
(xiii)	S-2347, sheet 1 of 1, Rev. A	+6m Extension with oblique view "E"
(xiv)	S-2348, sheet 1 of 1, Rev. A	+9m Extension with oblique view "F"
(xv)	PGCB/GtoG/01/1Q30/SD/01, Rev. 1	Detail Drawing of Stub & Cleat for Tower Type 1Q30
(xvi)	PGCB/Kfw-2.2/1Q30/SD/01, Rev. 0	Detail Drawing of Stub & Cleat with 2m Raised Chimney for Tower Type 1Q30

Item	Drawing Number	Title
(d)	Tower type 1QT6	
(i)	DS-1735, Sheet 1 of 1	Outline diagram for 132kV M/C tension tower (1QT6)
(ii)	S-2395, Sheet 1 of 1, Rev. 2	Structural drawing of GW X-Arm & X-Arm-6 of 1QT6 type tower
(iii)	S-2396, Sheet 1 of 1, Rev. 3	X-Arm-4 & X-Arm-5
(iv)	S-2397, Sheet 1 of 1, Rev. 3	X-Arm-2 & X-Arm-3
(v)	S-2398, Sheet 1 of 1, Rev. 3	X-Arm-1
(vi)	S-2399, Sheet 1 of 1, Rev. 1	Cage-I
(vii)	S-2400, Sheet 1 of 1, Rev. 2	Cage-2
(viii)	S-2401, Sheet 1 of 1, Rev. 2	Body
(ix)	S-2402, Sheet 1 of 1, Rev. 0	Basic Body
(x)	S-2403, Sheet 1 of 1, Rev. 0	0 Base
(xi)	S-2404, Sheet 1 of 1, Rev. 0	+9M Extension
(xii)	S-2405, Sheet 1 of 1, Rev. 1	Plan A-A & B-B
(xiii)	S-2411	+1.5M Extension
(xiv)	S-2412	+3M Extension
(xv)	S-2413	+4.5M Extension
(xvi)	S-2414, Sheet 1 of 1, Rev. 0	+6M Extension
(xvii)	S-2759, Sheet 1 of 1, Rev. 1	Aux. cross-arm GW & 6
(xviii)	S-2760, Sheet 1 of 1, Rev. 0	Aux. cross-arm 4 & 5
(xix)	S-2761, Sheet 1 of 1, Rev. 0	Aux. cross-arm 2 & 3
(xx)	S-2762, Sheet 1 of 1, Rev. 1	Aux. cross-arm 1
(xxi)	PGCB/GtoG/01/1QT6/SD/01, Rev. 1	Detail Drawing of Stub & Cleat for Tower Type 1QT6
(xxii)	PGCB/Kfw-2.2/1QT6/SD/01, Rev. 0	Detail Drawing of Stub & Cleat with 2m Raised Chimney for Tower Type 1QT6
**(xxiii)	PGCB/132kV/WB-P1/SP/ 1QT6/01, Sheet 1 of 1, Rev. 0	Structural Drawing for Single Peak of Tower Type 1QT6
**(xxiv)	PGCB/132kV/WB-P1/ST/ 1QT6/01, Sheet 1 of 1, Rev. 0	Plan View for Strengthening of 1QT6 Tower Peak to Connect Single OPGW at Mid (One Side)

***Note: The tower parts shown in these drawings shall be supplied and installed only when necessary in accordance with the plan and profile and line shielding requirement*

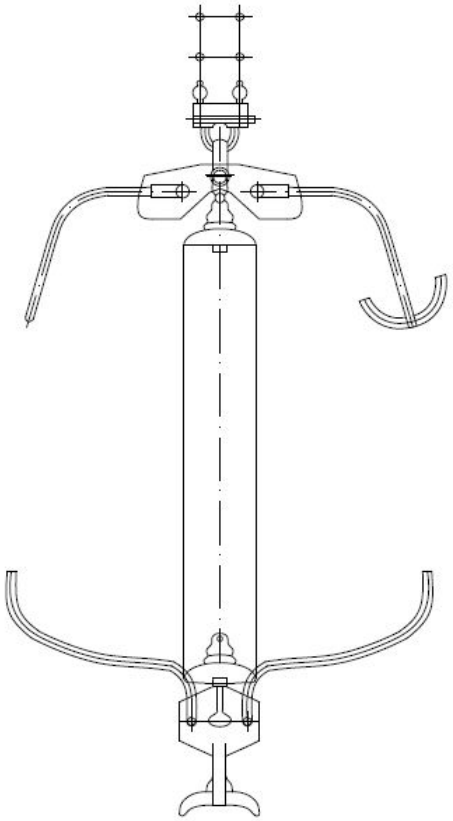
22.1.1 Drawings for 132kV Transmission Lines



Suspension Set (Overland Potion)

Tender Purpose Only

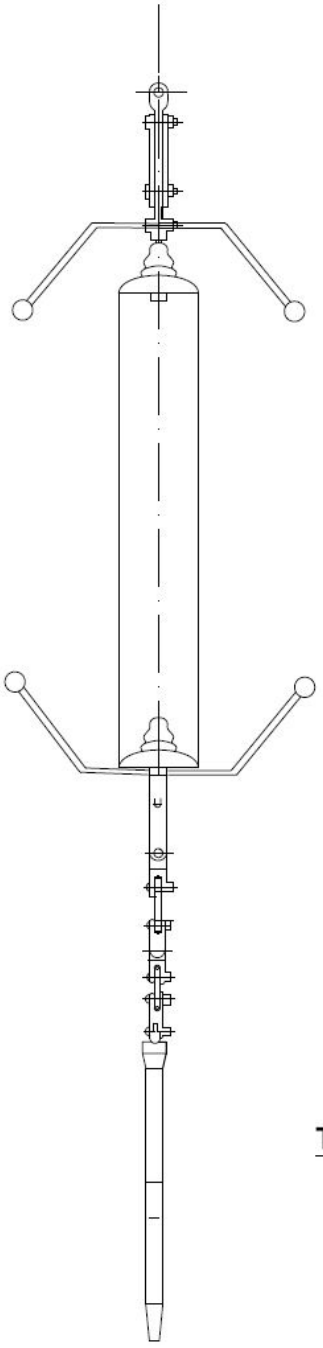
Drawing No. PGCB/132kV/SS
Title : Typical Drawing for Suspension Set - overhead line



Heavy Suspension Set (Overland Potion)

Tender Purpose Only

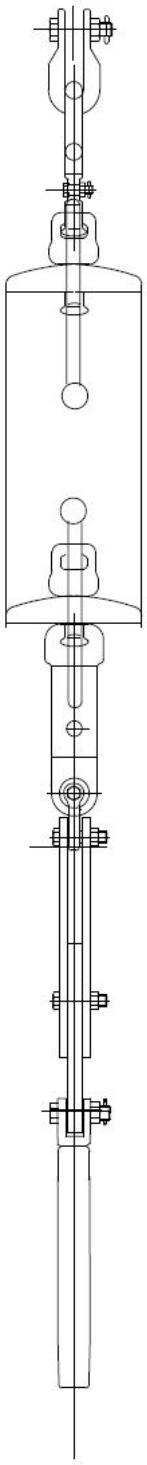
	Drawing No. PGCB/132kV/HS
	Title : Typical Drawing for Heavy Suspension Set - overhead line



Tension Insulator Set (Overland Potion)

Tender Purpose Only

	Drawing No. PGCB/132kV/TS
	Title : Typical Drawing for Tension Set - overhead line



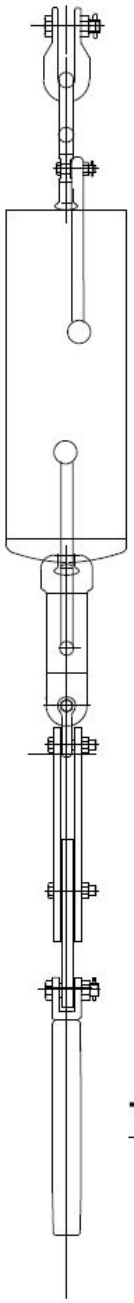
Upright Low Duty
Tension Insulator Set

Tender Purpose Only

Drawing No. PGCB/132kV/ULD

Title :

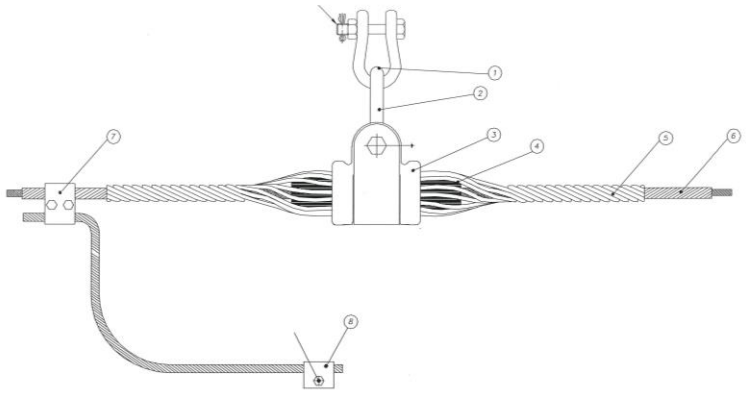
Typical Drawing for 132kV
Upright Low Duty Tension Set



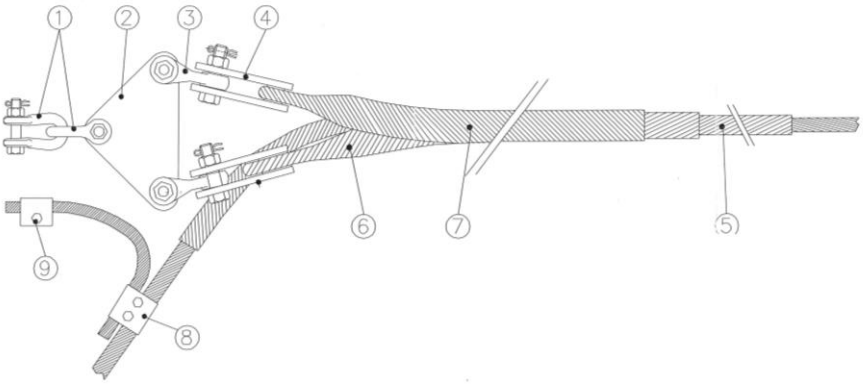
Inverted Low Duty Tension Insulator Set

Tender Purpose Only

	Drawing No. PGCB/132kV/ILD
	Title : Typical Drawing for 132kV Inverted Low Duty Tension Set

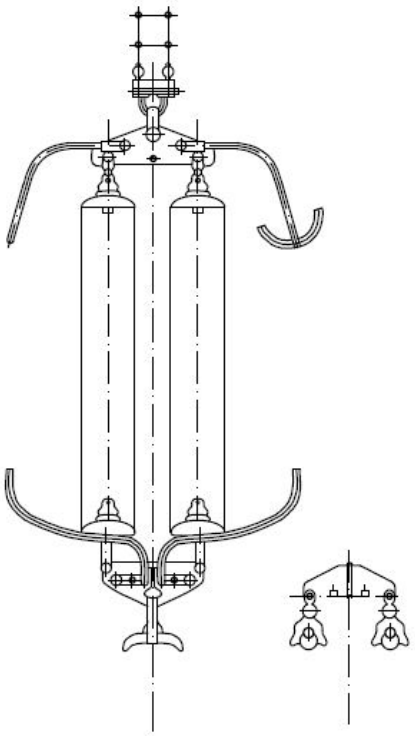


Typical Drawing of OPGW Suspension Set (Tender Purpose Only)



Typical Drawing of OPGW Tension Set (Tender Purpose Only)

22.1.2 Drawings for 230kV Transmission Lines– Not applicable

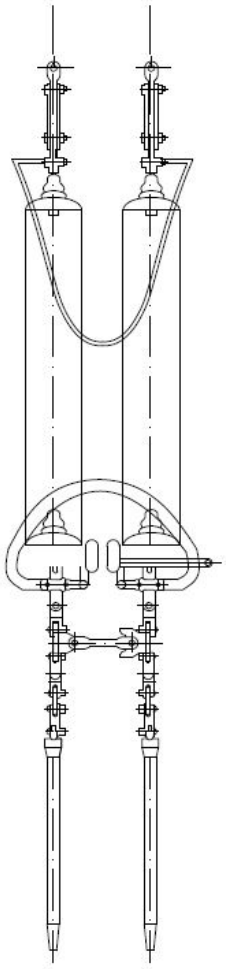


Suspension Set (Overland Potion)

Tender Purpose Only

Drawing No. PGCB/230kV/SS

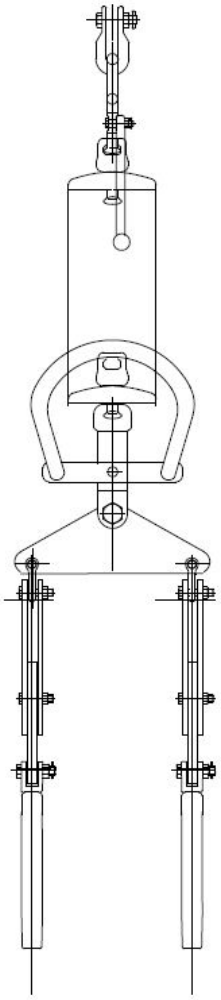
Title : Typical Drawing for Suspension Set - overhead line



Tenslon Insulator Set (Overland Potlon)

Tender Purpose Only

Drawing No.	PGCB/230kV/TS
Title :	Typlcal Drawlng for Tenslon Set - overhead llne

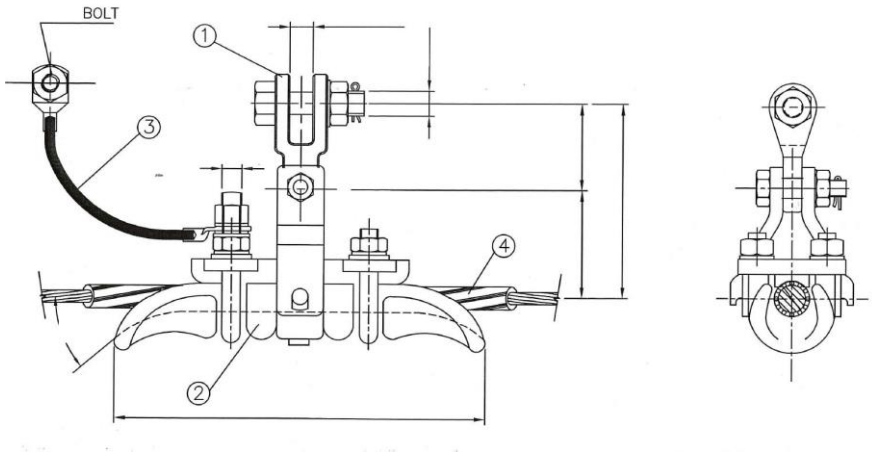


Upright Low DutyTension Insulator Set

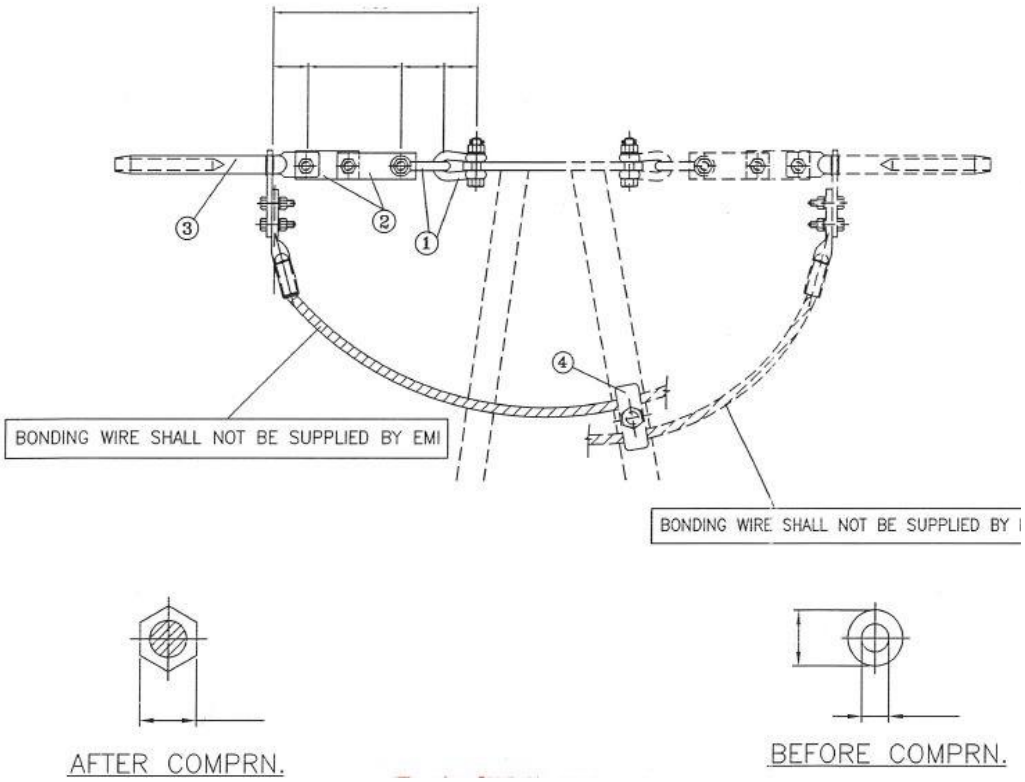
Tender Purpose Only

Drawing No. PGCB/230kV/ULD

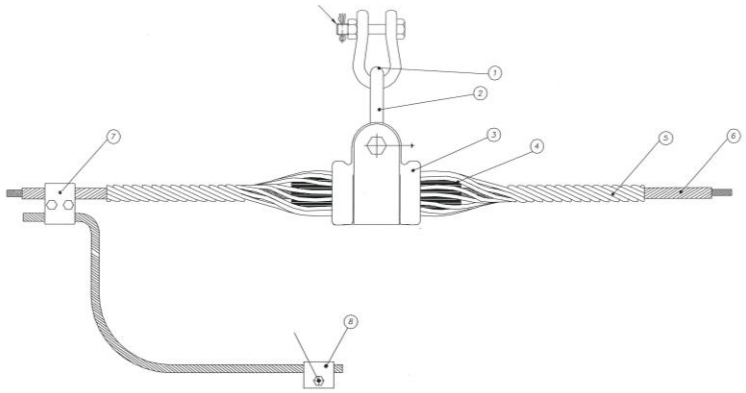
Title :
Typical Drawing for 400kV
Upright Low Duty Tension Set



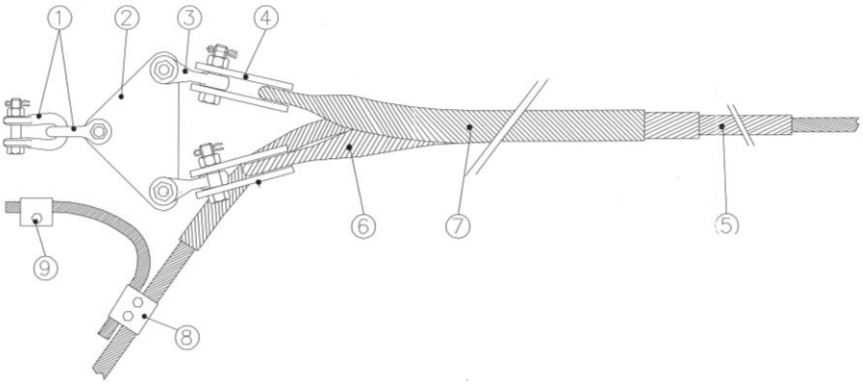
Typical Drawing of Earthwire Suspension Set (Tender Purpose Only)



Typical Drawing of Earthwire Tension Set (Tender Purpose Only)

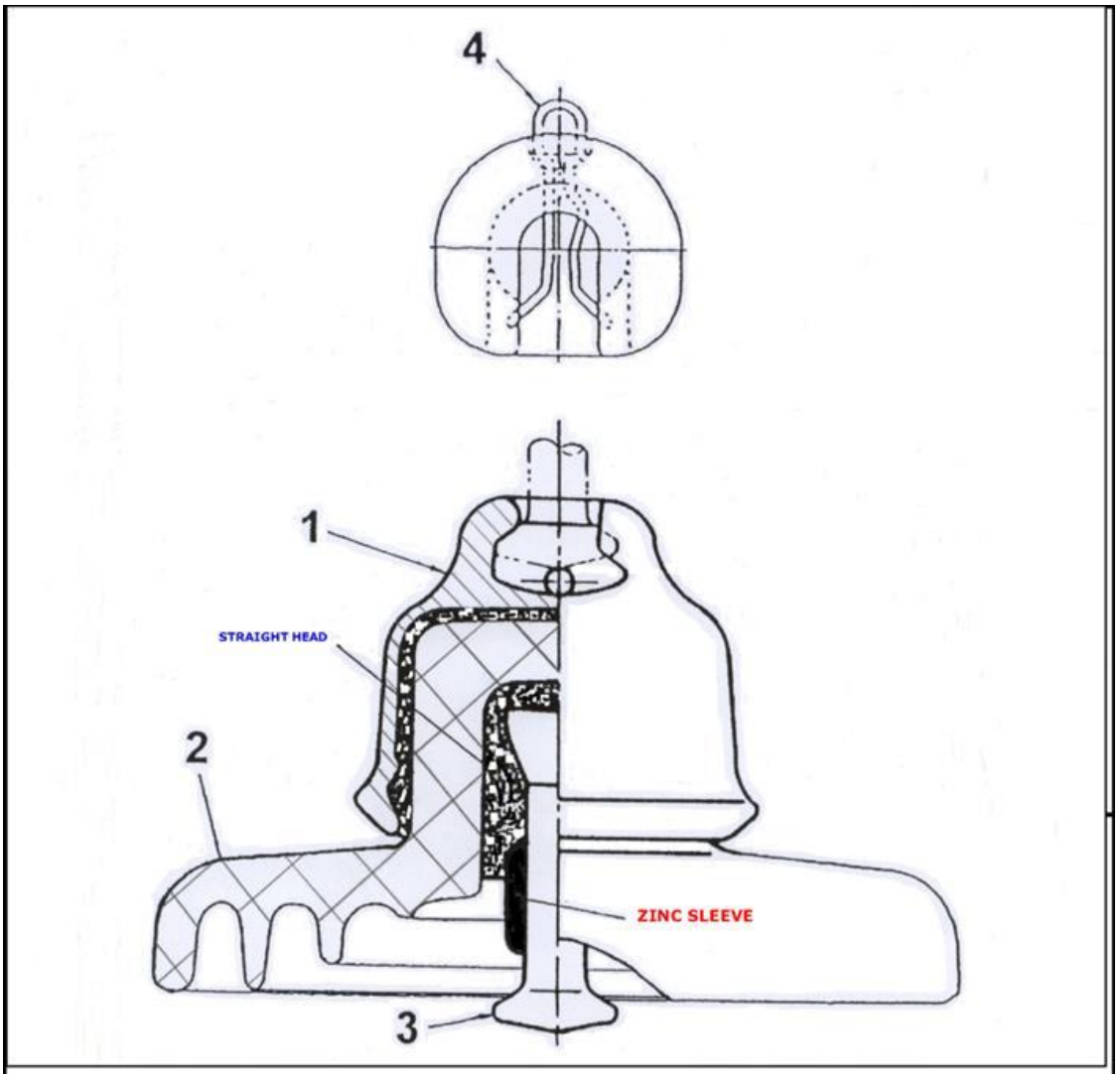


Typical Drawing of OPGW Suspension Set (Tender Purpose Only)



Typical Drawing of OPGW Tension Set (Tender Purpose Only)

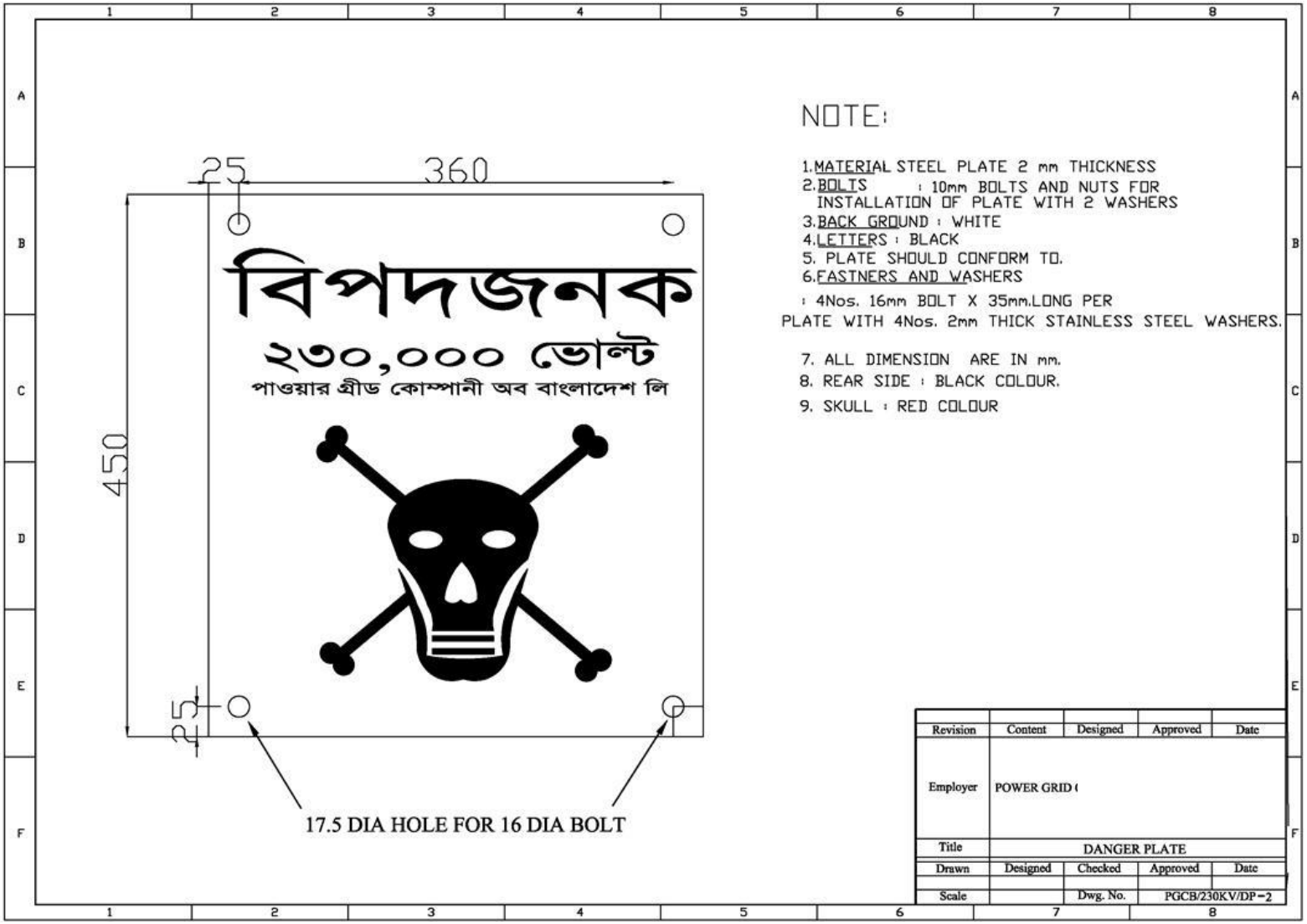
22.1.4 Insulators



1. CAP
2. PORCELAIN DISC
3. PIN
4. SECURITY CLIP

NOTE: BITUMINOUS PAINT COATING METAL SURFACES IN CONTACT WITH CEMENT

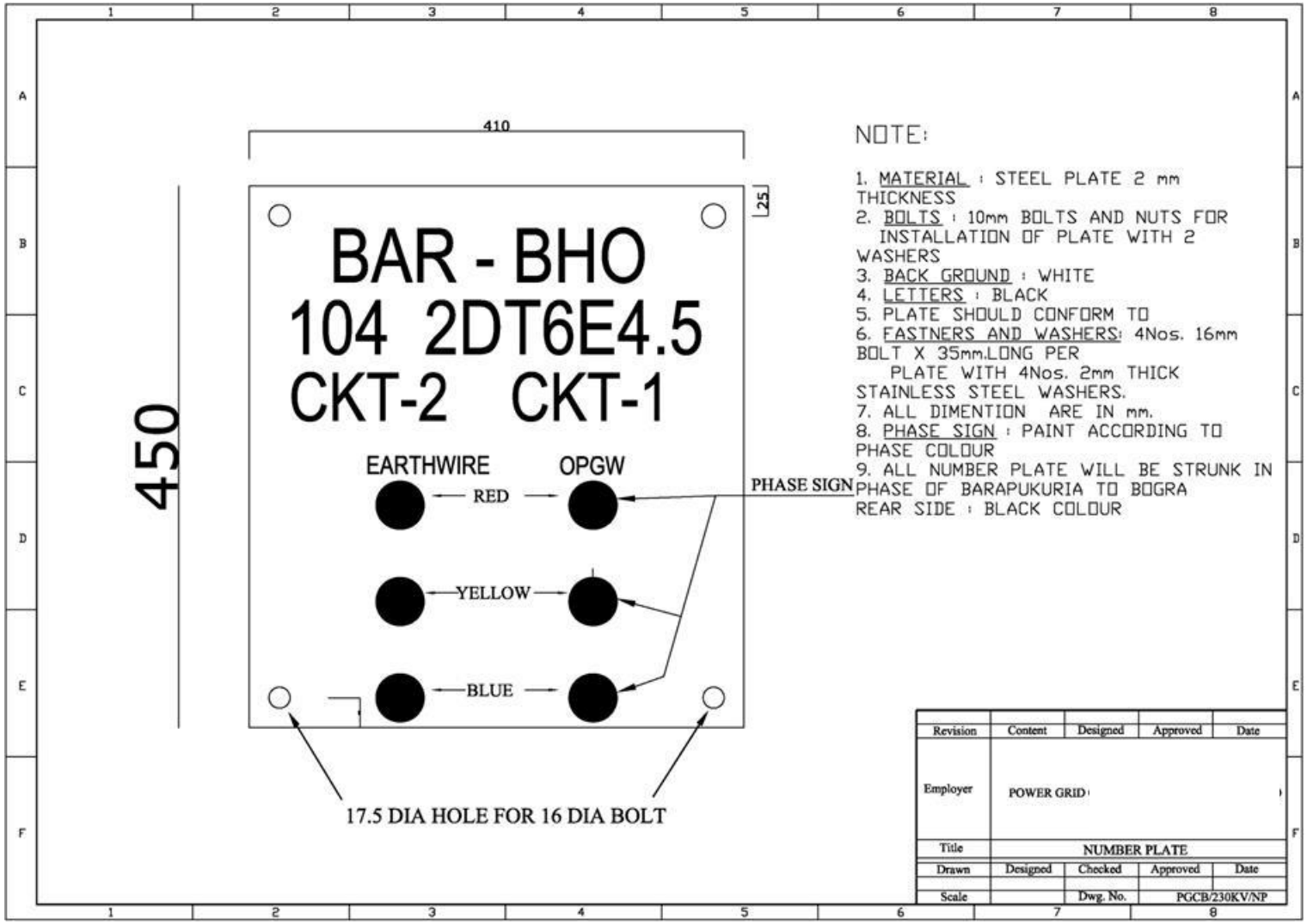
				TYPICAL DRAWING FOR INSULATOR SHOWING ZINC SLEEVE & STRAIGHT HEAD			
Designed by		Approved by		Catalogue No.:			
Verified by		Date		Drawing No.	PGCB/TL/INS	Weight(kg)	

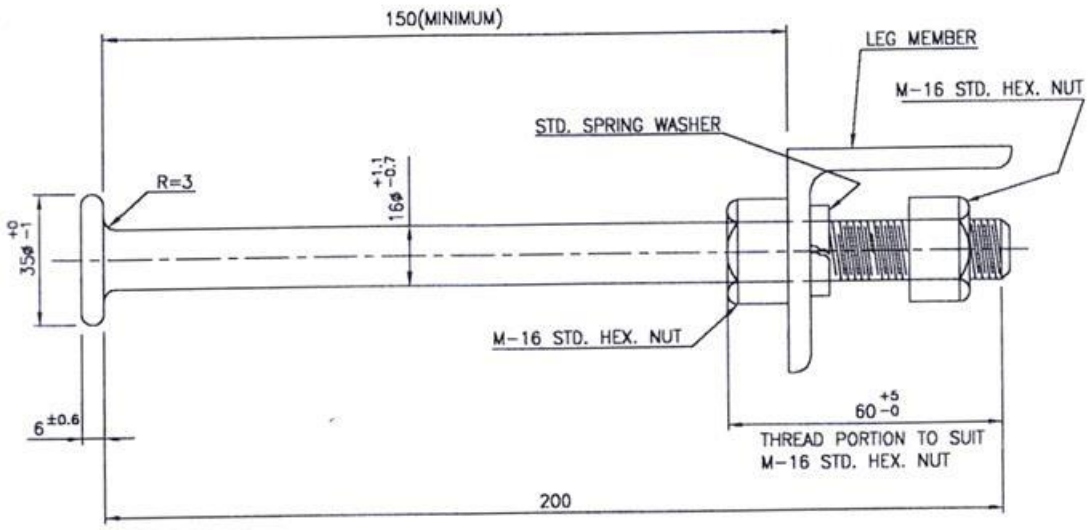


NOTE:

1. MATERIAL STEEL PLATE 2 mm THICKNESS
2. BOLTS : 10mm BOLTS AND NUTS FOR INSTALLATION OF PLATE WITH 2 WASHERS
3. BACK GROUND : WHITE
4. LETTERS : BLACK
5. PLATE SHOULD CONFORM TO.
6. FASTNERS AND WASHERS : 4Nos. 16mm BOLT X 35mm.LONG PER PLATE WITH 4Nos. 2mm THICK STAINLESS STEEL WASHERS.
7. ALL DIMENSION ARE IN mm.
8. REAR SIDE : BLACK COLOUR.
9. SKULL : RED COLOUR

Revision	Content	Designed	Approved	Date
Employer	POWER GRID (			
Title	DANGER PLATE			
Drawn	Designed	Checked	Approved	Date
Scale		Dwg. No.	PGCB/230KV/DP-2	


410
450
25
BAR - BHO
104 2DT6E4.5
CKT-2 CKT-1
EARTHWIRE
OPGW
RED
YELLOW
BLUE
PHASE SIGN
17.5 DIA HOLE FOR 16 DIA BOLT
NOTE:
1. MATERIAL : STEEL PLATE 2 mm THICKNESS
2. BOLTS : 10mm BOLTS AND NUTS FOR INSTALLATION OF PLATE WITH 2 WASHERS
3. BACK GROUND : WHITE
4. LETTERS : BLACK
5. PLATE SHOULD CONFORM TO
6. FASTNERS AND WASHERS: 4Nos. 16mm BOLT X 35mm.LONG PER PLATE WITH 4Nos. 2mm THICK STAINLESS STEEL WASHERS.
7. ALL DIMENTION ARE IN mm.
8. PHASE SIGN : PAINT ACCORDING TO PHASE COLOUR
9. ALL NUMBER PLATE WILL BE STRUNK IN PHASE OF BARAPUKURIA TO BOGRA REAR SIDE : BLACK COLOUR
Revision
Content
Designed
Approved
Date
Employer
POWER GRID
Title
NUMBER PLATE
Drawn
Designed
Checked
Approved
Date
Scale
Dwg. No.
PGCB/230KV/NP



NOTES :

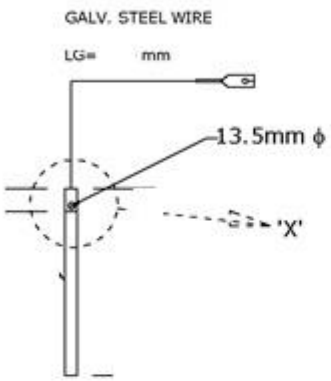
1. ALL DIMENSIONS ARE IN MM.
2. REFER TO SPECIFICATION FOR DETAILS
3. STEP-BOLT & NUTS TO BE GALVANISED AS PER BS:729.
4. NUT SHALL BE HEXAGONAL & SHALL BE AS PER IS:1363.
5. NUTS SHALL BE OF CLASS-5 CONFORMING TO IS:1367.
6. STEP-BOLT SHALL BE CAPABLE OF WITHSTANDING A VERTICAL LOAD OF NOT LES THAN 1.5KN.
7. STEEL FOR STEP BOLTS & NUTS SHALL BE GRADE S275JR.

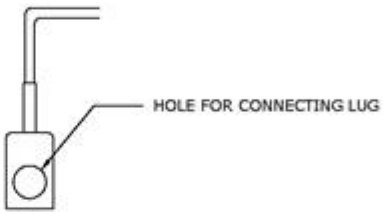
Drawing No. PGCB/SB

Title: Step Bolt

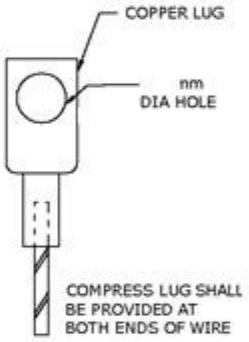
NOTES:

1. DIMENSION OF 'X' WILL BE DECIDED AT SITE AS PER SITE CONDITION
2. TO ENSURE THERE IS NO BIMETALLIC CORROSION THE COPPER LEG SHOULD BE TINNED
3. EARTHING ARRANGEMENT SHOULD BE CONNECTED FOR TWO DIAGONALS OF EACH TOWER
4. PLEASE REFER TO CHAPTER 8 FOR DETAILS OF TOWER EARTHING.

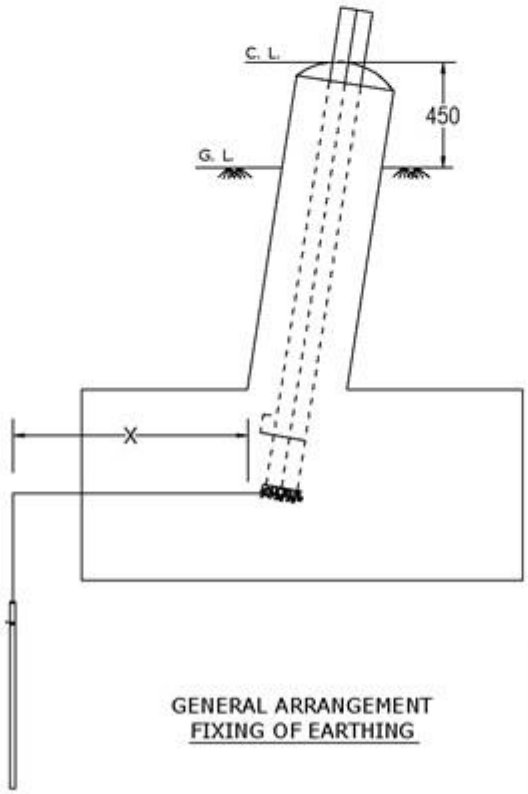




DETAIL OF 'X'



DETAIL OF LUG



GENERAL ARRANGEMENT
FIXING OF EARTHING

POWER GRID BANGLADESH

EARTHING ARRANGEMENT

23. Reference Data

The following documents are enclosed for tender purposes and reference only.

1 Line route data

23.1 Line Route Data

All coordinates listed in **Annex 23-1** and Route Maps in **Annex 23-2** are indicative only and meant to provide rough guideline and information on line routes.

23.2 Soil Investigation Report – Not applicable

The soil investigation report (soft copies) is indicative only and meant to provide rough guideline and information on soil data on line routes.

During execution if the soil investigation results found different values than the enclosed one, the Contractor has to do the works without any changed in the contract prices.

Satkhira- Paikgacha 132kv double circuit line								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1	736220.244	2498602.197	1.365	Gantry		101		
2	736136.6	2498551.483	1.324	TT No- 1		101	18°40'36"RT	
3	735872.2081	2498492.614	1.485	AP No- 1		101	44°10'45"RT	
4	735250.4663	2498875.446	1.621	AP No- 2		101	26°20'23"LT	
5	733182.0524	2499066.85	1.752	AP No- 3		101	12°2'8"RT	
6	732135.6364	2499393.22	1.702	AP No- 4		101	24°20'11"RT	
7	728846.363	2502319.686	1.368	AP No- 5		101	22°12'49"RT	
8	724842.2442	2510483.162	1.252	AP No- 6		101	29°58'31"LT	
9	719747.9781	2513906.669	1.263	AP No- 7		101	27°54'4"LT	
10	718461.9649	2514041.691	1.202	AP No- 8		101	36°57'36"RT	
11	715608.0614	2516698.821	1.152	AP No- 9		101	28°42'28"LT	
12	715213.074	2516799.179	1.702	AP No- 10		101	29°3'45"LT	
13	714984.0235	2516738.536	1.752	TT-02		101	29°56'55"LT	
14	714953.3701	2516708.212	1.895	Gantry		101		
15	736220.244	2498602.197	1.365	RL		200		
16	736177.491	2498576.275	1.284	RL		200		
17	736134.474	2498551.009	1.324	RL		200		
18	736085.669	2498540.143	1.374	RL		200		
19	736036.864	2498529.276	1.421	RL		200		
20	735988.059	2498518.409	1.464	RL		200		
21	735939.254	2498507.543	1.532	RL		200		
22	735890.449	2498496.676	1.436	RL		200		
23	735590.101	2498666.349	1.485	RL		200		
24	735547.527	2498692.568	1.521	RL		200		
25	735504.953	2498718.787	1.254	RL		200		
26	735377.231	2498797.444	1.384	RL		200		
27	735334.656	2498823.663	1.457	RL		200		
28	735292.082	2498849.882	1.562	RL		200		
29	735249.345	2498875.612	1.621	RL		200		
30	735199.558	2498880.219	1.5741	RL		200		
31	735149.77	2498884.827	1.587	RL		200		
32	735099.983	2498889.434	1.574	RL		200		
33	735050.196	2498894.041	1.532	RL		200		
34	734986.402	2498899.944	1.584	RL		200		
35	734950.621	2498903.255	1.547	RL		200		
36	734900.834	2498907.862	1.454	RL		200		
37	734851.047	2498912.469	1.432	RL		200		
38	734801.259	2498917.076	1.464	RL		200		
39	734756.167	2498921.249	1.536	RL		200		
40	734701.685	2498926.291	1.574	RL		200		
41	734651.897	2498930.898	1.621	RL		200		
42	733063.796	2499103.799	1.754	RL		200		
43	732789.602	2499189.318	1.721	RL		200		
44	732777.403	2499193.123	1.762	RL		200		
45	732688.139	2499220.964	1.621	RL		200		
46	732634.206	2499237.785	1.652	RL		200		
47	732570.307	2499257.715	1.692	RL		200		
48	732491.009	2499282.447	1.654	RL		200		
49	732443.277	2499297.335	1.694	RL		200		
50	732395.545	2499312.222	1.732	RL		200		
51	732328.21	2499333.223	1.764	RL		200		
52	732300.08	2499341.997	1.72	RL		200		
53	732252.348	2499356.884	1.65	RL		200		
54	732204.616	2499371.772	1.685	RL		200		
55	732156.884	2499386.659	1.732	RL		200		
56	728902.31	2502269.912	1.214	RL		200		
57	728864.954	2502303.146	1.256	RL		200		
58	735712.556	2498590.935	2.989	RL		200		
59	735718.641	2498587.188	2.958	RL		200		
60	734975.117	2498900.988	1.621	RL		200		
61	734743.879	2498922.396	1.621	RL		200		
62	734632.004	2498932.739	1.547	RL		200		
63	734582.216	2498937.346	1.454	RL		200		
64	734532.429	2498941.953	1.432	RL		200		
65	734482.642	2498946.56	1.464	RL		200		
66	734449.883	2498949.592	1.547	RL		200		
67	734400.095	2498954.199	1.454	RL		200		
68	734350.308	2498958.806	1.432	RL		200		
69	734300.521	2498963.413	1.464	RL		200		
70	734272.758	2498965.982	1.547	RL		200		
71	734222.971	2498970.589	1.454	RL		200		
72	734173.184	2498975.196	1.432	RL		200		
73	734123.396	2498979.803	1.464	RL		200		
74	734090.637	2498982.835	1.547	RL		200		
75	734040.85	2498987.442	1.454	RL		200		
76	733991.063	2498992.049	1.432	RL		200		

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
77	733941.276	2498996.656	1.464	RL		200		
78	733895.7	2499000.873	1.547	RL		200		
79	733845.913	2499005.481	1.454	RL		200		
80	733796.125	2499010.088	1.432	RL		200		
81	733746.338	2499014.695	1.464	RL		200		
82	733713.579	2499017.726	1.547	RL		200		
83	733663.792	2499022.333	1.454	RL		200		
84	733614.004	2499026.941	1.432	RL		200		
85	733564.217	2499031.548	1.464	RL		200		
86	733530.159	2499034.699	1.547	RL		200		
87	733480.372	2499039.306	1.454	RL		200		
88	733430.585	2499043.913	1.432	RL		200		
89	733380.797	2499048.521	1.464	RL		200		
90	733348.038	2499051.552	1.547	RL		200		
91	733298.251	2499056.159	1.454	RL		200		
92	733248.464	2499060.766	1.432	RL		200		
93	732317.902	2499336.438	1.764	RL		200		
94	732113.319	2499413.152	1.521	RL		200		
95	732095.842	2499428.701	1.402	RL		200		
96	732053.822	2499466.085	1.186	RL		200		
97	732016.466	2499499.319	1.185	RL		200		
98	731979.111	2499532.554	1.181	RL		200		
99	731941.755	2499565.789	1.179	RL		200		
100	731904.399	2499599.023	1.176	RL		200		
101	731867.043	2499632.258	1.173	RL		200		
102	731829.729	2499665.455	1.171	RL		200		
103	731784.719	2499705.5	1.245	RL		200		
104	731719.366	2499763.643	1.165	RL		200		
105	729521.969	2501718.615	1.158	RL		200		
106	729430.412	2501800.071	1.402	RL		200		
107	729388.393	2501837.455	1.186	RL		200		
108	729351.037	2501870.689	1.185	RL		200		
109	729313.681	2501903.924	1.181	RL		200		
110	729276.325	2501937.159	1.179	RL		200		
111	729238.969	2501970.393	1.176	RL		200		
112	729201.614	2502003.628	1.173	RL		200		
113	729164.3	2502036.825	1.171	RL		200		
114	729128.648	2502068.544	1.169	RL		200		
115	729091.292	2502101.778	1.167	RL		200		
116	729053.936	2502135.013	1.165	RL		200		
117	729016.58	2502168.248	1.162	RL		200		
118	728979.225	2502201.482	1.16	RL		200		
119	728941.869	2502234.717	1.158	RL		200		
120	731753.815	2499732.994	1.354	RL		200		
121	729470.623	2501764.297	1.402	RL		200		
122	731682.01	2499796.877	1.162	RL		200		
123	731607.298	2499863.347	1.158	RL		200		
124	731568.145	2499898.18	1.402	RL		200		
125	731526.126	2499935.564	1.186	RL		200		
126	731488.77	2499968.799	1.185	RL		200		
127	731451.414	2500002.033	1.181	RL		200		
128	731414.058	2500035.268	1.179	RL		200		
129	731376.702	2500068.502	1.176	RL		200		
130	731339.346	2500101.737	1.173	RL		200		
131	731302.032	2500134.934	1.171	RL		200		
132	731266.381	2500166.653	1.169	RL		200		
133	731229.025	2500199.888	1.167	RL		200		
134	731191.669	2500233.122	1.165	RL		200		
135	731154.313	2500266.357	1.162	RL		200		
136	731116.957	2500299.591	1.16	RL		200		
137	731085.59	2500327.498	1.485	RL		200		
138	731055.936	2500353.881	1.402	RL		200		
139	731013.917	2500391.264	1.186	RL		200		
140	730976.561	2500424.499	1.185	RL		200		
141	730939.205	2500457.734	1.181	RL		200		
142	730901.849	2500490.968	1.179	RL		200		
143	730827.137	2500557.438	1.173	RL		200		
144	730789.823	2500590.635	1.171	RL		200		
145	730754.172	2500622.353	1.169	RL		200		
146	730716.816	2500655.588	1.167	RL		200		
147	730642.104	2500722.057	1.162	RL		200		
148	730604.748	2500755.292	1.16	RL		200		
149	730567.392	2500788.527	1.158	RL		200		
150	730530.246	2500821.574	1.402	RL		200		
151	730488.227	2500858.958	1.186	RL		200		
152	730376.16	2500958.662	1.179	RL		200		
153	730338.804	2500991.897	1.176	RL		200		
154	730301.448	2501025.131	1.173	RL		200		
155	730264.134	2501058.329	1.171	RL		200		

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
156	730228.482	2501090.047	1.169	RL		200		
157	730153.77	2501156.516	1.165	RL		200		
158	730079.059	2501222.986	1.16	RL		200		
159	730010.513	2501283.969	1.402	RL		200		
160	729968.494	2501321.353	1.186	RL		200		
161	729931.138	2501354.587	1.185	RL		200		
162	729893.782	2501387.822	1.181	RL		200		
163	729856.426	2501421.057	1.179	RL		200		
164	729819.07	2501454.291	1.176	RL		200		
165	729781.714	2501487.526	1.173	RL		200		
166	729744.4	2501520.723	1.171	RL		200		
167	729634.037	2501618.911	1.165	RL		200		
168	729596.681	2501652.146	1.162	RL		200		
169	729559.325	2501685.38	1.16	RL		200		
170	731093.429	2500320.524	1.421	RL		200		
171	728790.453	2502433.673	1.214	RL		200		
172	728812.472	2502388.782	1.256	RL		200		
173	727130.003	2505818.949	1.165	RL		200		
174	728423.431	2503181.946	1.395	RL		200		
175	728479.175	2503068.298	1.402	RL		200		
176	728499.889	2503026.066	1.265	RL		200		
177	728525.961	2502972.912	1.185	RL		200		
178	728547.98	2502928.021	1.181	RL		200		
179	728569.998	2502883.13	1.179	RL		200		
180	728592.017	2502838.24	1.176	RL		200		
181	728614.035	2502793.349	1.173	RL		200		
182	728636.029	2502748.508	1.171	RL		200		
183	728657.043	2502705.665	1.169	RL		200		
184	728679.062	2502660.775	1.167	RL		200		
185	728701.08	2502615.884	1.165	RL		200		
186	728723.099	2502570.993	1.162	RL		200		
187	728745.118	2502526.102	1.16	RL		200		
188	728767.136	2502481.212	1.158	RL		200		
189	727109.697	2505860.347	1.354	RL		200		
190	728455.474	2503116.619	1.402	RL		200		
191	727152.021	2505774.058	1.162	RL		200		
192	727196.059	2505684.277	1.158	RL		200		
193	727219.136	2505637.226	1.402	RL		200		
194	727243.904	2505586.731	1.186	RL		200		
195	727265.922	2505541.84	1.185	RL		200		
196	727287.941	2505496.949	1.181	RL		200		
197	727309.96	2505452.059	1.179	RL		200		
198	727331.978	2505407.168	1.176	RL		200		
199	727353.997	2505362.277	1.173	RL		200		
200	727377.559	2505314.239	1.341	RL		200		
201	727441.042	2505184.812	1.165	RL		200		
202	727463.06	2505139.921	1.162	RL		200		
203	727485.079	2505095.031	1.16	RL		200		
204	727503.568	2505057.336	1.485	RL		200		
205	727521.047	2505021.701	1.402	RL		200		
206	727545.814	2504971.206	1.186	RL		200		
207	727567.833	2504926.315	1.185	RL		200		
208	727589.851	2504881.424	1.181	RL		200		
209	727611.87	2504836.533	1.179	RL		200		
210	727655.907	2504746.752	1.173	RL		200		
211	727677.901	2504701.911	1.171	RL		200		
212	727698.915	2504659.068	1.169	RL		200		
213	727720.933	2504614.178	1.167	RL		200		
214	727764.971	2504524.396	1.162	RL		200		
215	727786.989	2504479.505	1.16	RL		200		
216	727809.008	2504434.615	1.158	RL		200		
217	727830.903	2504389.976	1.402	RL		200		
218	727855.67	2504339.481	1.186	RL		200		
219	727921.726	2504204.809	1.179	RL		200		
220	727943.744	2504159.918	1.176	RL		200		
221	727965.763	2504115.027	1.173	RL		200		
222	727987.757	2504070.187	1.171	RL		200		
223	728008.771	2504027.344	1.169	RL		200		
224	728052.808	2503937.562	1.165	RL		200		
225	728137.248	2503765.409	1.402	RL		200		
226	728162.015	2503714.914	1.186	RL		200		
227	728184.034	2503670.023	1.185	RL		200		
228	728206.052	2503625.132	1.181	RL		200		
229	728237.083	2503561.868	1.179	RL		200		
230	728272.108	2503490.46	1.173	RL		200		
231	728294.102	2503445.619	1.171	RL		200		
232	728359.153	2503312.995	1.165	RL		200		
233	728381.172	2503268.104	1.162	RL		200		
234	728403.19	2503223.213	1.16	RL		200		

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
235	727498.947	2505066.756	1.421	RL		200		
236	727071.716	2505937.783	1.214	RL		200		
237	727093.734	2505892.893	1.256	RL		200		
238	725411.265	2509323.059	1.165	RL		200		
239	726706.471	2506682.433	1.158	RL		200		
240	726760.437	2506572.408	1.402	RL		200		
241	726785.205	2506521.913	1.186	RL		200		
242	726807.223	2506477.022	1.185	RL		200		
243	726829.242	2506432.131	1.181	RL		200		
244	726851.261	2506387.24	1.179	RL		200		
245	726873.279	2506342.35	1.176	RL		200		
246	726895.298	2506297.459	1.173	RL		200		
247	726917.292	2506252.618	1.171	RL		200		
248	726938.306	2506209.776	1.169	RL		200		
249	726960.324	2506164.885	1.167	RL		200		
250	726982.343	2506119.994	1.165	RL		200		
251	727004.361	2506075.103	1.162	RL		200		
252	727026.38	2506030.212	1.16	RL		200		
253	727048.398	2505985.322	1.158	RL		200		
254	725390.96	2509364.457	1.354	RL		200		
255	726736.736	2506620.729	1.402	RL		200		
256	725433.284	2509278.168	1.162	RL		200		
257	725477.321	2509188.387	1.158	RL		200		
258	725500.399	2509141.336	1.402	RL		200		
259	725525.166	2509090.841	1.186	RL		200		
260	725547.185	2509045.95	1.185	RL		200		
261	725569.203	2509001.06	1.181	RL		200		
262	725591.222	2508956.169	1.179	RL		200		
263	725613.24	2508911.278	1.176	RL		200		
264	725635.259	2508866.387	1.173	RL		200		
265	725657.253	2508821.547	1.171	RL		200		
266	725681.093	2508772.942	1.169	RL		200		
267	725687.133	2508760.629	1.167	RL		200		
268	725722.304	2508688.922	1.165	RL		200		
269	725744.323	2508644.032	1.162	RL		200		
270	725766.341	2508599.141	1.16	RL		200		
271	725784.83	2508561.447	1.485	RL		200		
272	725802.309	2508525.811	1.402	RL		200		
273	725827.076	2508475.316	1.186	RL		200		
274	725849.095	2508430.425	1.185	RL		200		
275	725871.114	2508385.534	1.181	RL		200		
276	725893.132	2508340.644	1.179	RL		200		
277	725937.169	2508250.862	1.173	RL		200		
278	725959.163	2508206.021	1.171	RL		200		
279	725980.177	2508163.179	1.169	RL		200		
280	726002.196	2508118.288	1.167	RL		200		
281	726046.233	2508028.506	1.162	RL		200		
282	726068.251	2507983.615	1.16	RL		200		
283	726090.27	2507938.725	1.158	RL		200		
284	726112.165	2507894.086	1.402	RL		200		
285	726136.932	2507843.591	1.186	RL		200		
286	726202.988	2507708.919	1.179	RL		200		
287	726225.007	2507664.028	1.176	RL		200		
288	726247.025	2507619.137	1.173	RL		200		
289	726274.202	2507563.729	1.171	RL		200		
290	726281.167	2507549.53	1.169	RL		200		
291	726334.07	2507441.672	1.165	RL		200		
292	726372.739	2507362.835	1.16	RL		200		
293	726443.277	2507219.024	1.186	RL		200		
294	726465.296	2507174.133	1.185	RL		200		
295	726531.352	2507039.461	1.176	RL		200		
296	726553.37	2506994.57	1.173	RL		200		
297	726575.364	2506949.729	1.171	RL		200		
298	726640.415	2506817.105	1.165	RL		200		
299	726662.434	2506772.214	1.162	RL		200		
300	726684.453	2506727.323	1.16	RL		200		
301	725780.21	2508570.866	1.421	RL		200		
302	725344.147	2509459.898	1.214	RL		200		
303	725366.165	2509415.007	1.256	RL		200		
304	725032.869	2510094.522	1.402	RL		200		
305	725057.636	2510044.027	1.186	RL		200		
306	725079.655	2509999.137	1.185	RL		200		
307	725101.673	2509954.246	1.181	RL		200		
308	725123.692	2509909.355	1.179	RL		200		
309	725157.805	2509839.806	1.501	RL		200		
310	725164.213	2509826.741	1.542	RL		200		
311	725189.723	2509774.733	1.171	RL		200		
312	725210.737	2509731.89	1.169	RL		200		
313	725232.756	2509686.999	1.167	RL		200		

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
314	725254.774	2509642.109	1.165	RL		200		
315	725276.793	2509597.218	1.162	RL		200		
316	725298.811	2509552.327	1.16	RL		200		
317	725320.83	2509507.436	1.158	RL		200		
318	724847.796	2510471.844	1.171	RL		200		
319	724912.847	2510339.22	1.165	RL		200		
320	724934.865	2510294.329	1.162	RL		200		
321	724956.884	2510249.438	1.16	RL		200		
322	728834.143	2502344.6	1.325	RL		200		
323	728494.385	2503037.287	1.295	RL		200		
324	728430.511	2503167.512	1.362	RL		200		
325	728098.542	2503844.322	1.262	RL		200		
326	727877.688	2504294.59	1.158	RL		200		
327	727899.583	2504249.952	1.402	RL		200		
328	727743.804	2504567.55	1.171	RL		200		
329	726183.73	2507748.182	1.285	RL		200		
330	724383.139	2510792.291	1.165	RL		200		
331	724344.865	2510818.007	1.354	RL		200		
332	724424.641	2510764.406	1.162	RL		200		
333	724551.143	2510679.409	1.402	RL		200		
334	724597.826	2510648.042	1.186	RL		200		
335	724639.328	2510620.157	1.185	RL		200		
336	724680.83	2510592.272	1.181	RL		200		
337	724722.332	2510564.386	1.179	RL		200		
338	724763.834	2510536.501	1.176	RL		200		
339	724805.336	2510508.616	1.173	RL		200		
340	724256.63	2510877.293	1.214	RL		200		
341	724298.132	2510849.408	1.256	RL		200		
342	723965.562	2511072.863	1.171	RL		200		
343	724005.171	2511046.249	1.169	RL		200		
344	724046.673	2511018.364	1.167	RL		200		
345	724088.175	2510990.479	1.165	RL		200		
346	724129.676	2510962.594	1.162	RL		200		
347	724171.178	2510934.708	1.16	RL		200		
348	724212.68	2510906.823	1.158	RL		200		
349	723509.724	2511379.141	1.165	RL		200		
350	723471.45	2511404.857	1.354	RL		200		
351	723640.892	2511291.009	1.285	RL		200		
352	723677.728	2511266.259	1.402	RL		200		
353	723746.164	2511220.276	1.365	RL		200		
354	723807.415	2511179.122	1.181	RL		200		
355	723848.917	2511151.236	1.179	RL		200		
356	723890.419	2511123.351	1.176	RL		200		
357	723931.921	2511095.466	1.173	RL		200		
358	723383.215	2511464.143	1.214	RL		200		
359	723424.717	2511436.258	1.256	RL		200		
360	723092.147	2511659.712	1.171	RL		200		
361	723131.756	2511633.099	1.169	RL		200		
362	723173.258	2511605.214	1.167	RL		200		
363	723214.76	2511577.329	1.165	RL		200		
364	723256.261	2511549.443	1.162	RL		200		
365	723297.763	2511521.558	1.16	RL		200		
366	723339.265	2511493.673	1.158	RL		200		
367	722635.681	2511966.413	1.165	RL		200		
368	722597.407	2511992.129	1.354	RL		200		
369	722677.183	2511938.528	1.162	RL		200		
370	722760.186	2511882.758	1.158	RL		200		
371	722803.685	2511853.531	1.402	RL		200		
372	722933.372	2511766.394	1.181	RL		200		
373	722974.874	2511738.508	1.179	RL		200		
374	723016.376	2511710.623	1.176	RL		200		
375	723057.878	2511682.738	1.173	RL		200		
376	722509.172	2512051.415	1.214	RL		200		
377	722550.674	2512023.53	1.256	RL		200		
378	722218.104	2512246.984	1.171	RL		200		
379	722257.713	2512220.371	1.169	RL		200		
380	722299.214	2512192.486	1.167	RL		200		
381	722340.716	2512164.601	1.165	RL		200		
382	722382.218	2512136.715	1.162	RL		200		
383	722423.72	2512108.83	1.16	RL		200		
384	722465.222	2512080.945	1.158	RL		200		
385	721761.804	2512553.574	1.165	RL		200		
386	721723.531	2512579.289	1.354	RL		200		
387	721803.306	2512525.688	1.162	RL		200		
388	721886.31	2512469.918	1.158	RL		200		
389	721929.809	2512440.691	1.402	RL		200		
390	721976.492	2512409.324	1.186	RL		200		
391	722017.993	2512381.439	1.185	RL		200		
392	722059.495	2512353.554	1.181	RL		200		

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393	722100.997	2512325.669	1.179	RL		200		
394	722142.499	2512297.783	1.176	RL		200		
395	722184.001	2512269.898	1.173	RL		200		
396	721635.295	2512638.575	1.214	RL		200		
397	721676.797	2512610.69	1.256	RL		200		
398	721344.227	2512834.145	1.171	RL		200		
399	721383.836	2512807.532	1.169	RL		200		
400	721425.338	2512779.646	1.167	RL		200		
401	721466.84	2512751.761	1.165	RL		200		
402	721549.844	2512695.99	1.16	RL		200		
403	721591.346	2512668.105	1.158	RL		200		
404	720872.347	2513151.202	1.165	RL		200		
405	720834.074	2513176.918	1.354	RL		200		
406	720913.849	2513123.317	1.162	RL		200		
407	720996.853	2513067.546	1.158	RL		200		
408	721040.352	2513038.319	1.402	RL		200		
409	721087.035	2513006.953	1.186	RL		200		
410	721128.537	2512979.068	1.185	RL		200		
411	721170.039	2512951.182	1.181	RL		200		
412	721211.541	2512923.297	1.179	RL		200		
413	721253.042	2512895.412	1.176	RL		200		
414	721294.544	2512867.527	1.173	RL		200		
415	720787.34	2513208.319	1.256	RL		200		
416	720454.77	2513431.773	1.171	RL		200		
417	720502.235	2513399.881	1.169	RL		200		
418	720512.622	2513392.902	1.167	RL		200		
419	720009.091	2513731.226	1.165	RL		200		
420	720050.593	2513703.341	1.162	RL		200		
421	720133.597	2513647.57	1.158	RL		200		
422	720177.096	2513618.343	1.402	RL		200		
423	720223.779	2513586.977	1.186	RL		200		
424	720265.281	2513559.092	1.185	RL		200		
425	720306.783	2513531.207	1.181	RL		200		
426	720348.285	2513503.321	1.179	RL		200		
427	720389.787	2513475.436	1.176	RL		200		
428	720431.289	2513447.551	1.173	RL		200		
429	719755.629	2513901.528	1.162	RL		200		
430	719797.131	2513873.643	1.16	RL		200		
431	719838.633	2513845.758	1.158	RL		200		
432	723740.87	2511223.834	2.358	RL		200		
433	723651.855	2511283.643	1.265	RL		200		
434	722907.955	2511783.471	1.352	RL		200		
435	722840.4	2511828.862	1.245	RL		200		
436	722714.724	2511913.304	1.165	RL		200		
437	720955.523	2513095.316	1.354	RL		200		
438	720598.18	2513335.416	1.165	RL		200		
439	719515.566	2513931.052	1.165	RL		200		
440	719469.708	2513935.869	1.354	RL		200		
441	719565.292	2513925.829	1.162	RL		200		
442	719716.864	2513909.908	1.402	RL		200		
443	719363.986	2513946.974	1.214	RL		200		
444	719413.713	2513941.75	1.256	RL		200		
445	719015.237	2513983.606	1.171	RL		200		
446	719062.695	2513978.621	1.169	RL		200		
447	719112.422	2513973.398	1.167	RL		200		
448	719162.148	2513968.174	1.165	RL		200		
449	719211.874	2513962.951	1.162	RL		200		
450	719261.601	2513957.728	1.16	RL		200		
451	719311.327	2513952.505	1.158	RL		200		
452	718468.512	2514041.033	1.165	RL		200		
453	718518.238	2514035.81	1.162	RL		200		
454	718617.691	2514025.363	1.158	RL		200		
455	718775.471	2514008.79	1.185	RL		200		
456	718825.197	2514003.567	1.181	RL		200		
457	718874.924	2513998.344	1.179	RL		200		
458	718924.65	2513993.121	1.176	RL		200		
459	719610.273	2513921.104	1.165	RL		200		
460	718268.983	2514221.36	1.165	RL		200		
461	718235.236	2514252.781	1.354	RL		200		
462	718305.577	2514187.288	1.162	RL		200		
463	718378.764	2514119.144	1.158	RL		200		
464	718417.119	2514083.433	1.402	RL		200		
465	718157.436	2514325.22	1.214	RL		200		
466	718194.03	2514291.149	1.256	RL		200		
467	717900.791	2514564.179	1.171	RL		200		
468	717935.715	2514531.661	1.169	RL		200		
469	717972.309	2514497.589	1.167	RL		200		
470	718028.126	2514445.619	1.452	RL		200		
471	718082.09	2514395.374	1.254	RL		200		

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472	718118.684	2514361.302	1.158	RL		200		
473	717498.454	2514938.788	1.165	RL		200		
474	717464.707	2514970.209	1.354	RL		200		
475	717535.048	2514904.716	1.162	RL		200		
476	717608.236	2514836.572	1.158	RL		200		
477	717646.59	2514800.861	1.402	RL		200		
478	717687.752	2514762.536	1.186	RL		200		
479	717724.346	2514728.464	1.185	RL		200		
480	717760.94	2514694.392	1.181	RL		200		
481	717797.533	2514660.32	1.179	RL		200		
482	717834.127	2514626.248	1.176	RL		200		
483	717870.721	2514592.176	1.173	RL		200		
484	717386.907	2515042.648	1.214	RL		200		
485	717423.501	2515008.576	1.256	RL		200		
486	717311.561	2515112.802	1.16	RL		200		
487	717348.155	2515078.73	1.158	RL		200		
488	718338.678	2514156.468	1.165	RL		200		
489	717137.439	2515274.925	1.165	RL		200		
490	717103.692	2515306.346	1.354	RL		200		
491	717174.033	2515240.853	1.162	RL		200		
492	717247.22	2515172.709	1.158	RL		200		
493	717285.575	2515136.998	1.402	RL		200		
494	717025.892	2515378.785	1.214	RL		200		
495	717062.486	2515344.713	1.256	RL		200		
496	716769.247	2515617.743	1.171	RL		200		
497	716804.171	2515585.226	1.169	RL		200		
498	716840.765	2515551.154	1.167	RL		200		
499	716877.359	2515517.082	1.165	RL		200		
500	716913.952	2515483.01	1.162	RL		200		
501	716950.546	2515448.938	1.16	RL		200		
502	716987.14	2515414.866	1.158	RL		200		
503	716403.504	2515958.281	1.162	RL		200		
504	716476.692	2515890.137	1.158	RL		200		
505	716515.046	2515854.426	1.402	RL		200		
506	716592.802	2515782.028	1.185	RL		200		
507	716629.396	2515747.956	1.181	RL		200		
508	716665.989	2515713.884	1.179	RL		200		
509	716702.583	2515679.813	1.176	RL		200		
510	716739.177	2515645.741	1.173	RL		200		
511	716302.502	2516052.323	1.256	RL		200		
512	716002.887	2516331.29	1.165	RL		200		
513	715969.14	2516362.711	1.354	RL		200		
514	716039.481	2516297.218	1.162	RL		200		
515	715891.34	2516435.15	1.214	RL		200		
516	715927.933	2516401.078	1.256	RL		200		
517	715669.619	2516641.591	1.169	RL		200		
518	715706.213	2516607.519	1.167	RL		200		
519	715604.625	2516702.106	1.173	RL		200		
520	715381.727	2516756.352	1.574	RL		200		
521	715337.035	2516767.701	1.4885	RL		200		
522	715577.907	2516706.535	1.402	RL		200		
523	715234.003	2516793.865	1.214	RL		200		
524	715282.465	2516781.558	1.625	RL		200		
525	715480.358	2516731.306	1.794	RL		200		
526	714959.504	2516714.295	1.823	RL		200		
527	714977.371	2516732.015	1.721	RL		200		
528	715003.428	2516744.427	1.689	RL		200		
529	715051.766	2516757.211	1.754	RL		200		
530	715100.104	2516769.995	1.789	RL		200		
531	715196.78	2516795.563	1.725	RL		200		
532	718969.368	2513988.424	1.595	RL		200		
533	717996.426	2514475.134	1.452	RL		200		
534	717208.898	2515208.39	1.641	RL		200		
535	717201.314	2515215.452	1.641	RL		200		
536	715489.689	2516729.062	1.764	RL		200		
537	715500.75	2516726.128	1.521	RL		200		
538	715138.035	2516779.333	1.725	RL		200		
539	729679.658	2501578.323	1.167	11 kV Line Ht.	10.220	11		
540	719903.195	2513802.378	2.754	11 kV Line Ht.	8.510	11		
541	718980.571	2513987.247	1.521	11 kV Line Ht.	8.810	11		
542	723534.779	2511362.307	1.452	11 kV Line Ht.	8.950	11		
543	716363.851	2515995.201	1.165	11 kV Line Ht.	9.110	11		
544	716313.34	2516042.232	1.485	11 kV Line Ht.	9.110	11		
545	717215.024	2515202.687	1.365	11 kV Line Ht.	9.110	11		
546	715624.411	2516683.683	1.171	11 kV Line Ht.	9.110	11		
547	715766.229	2516551.639	1.165	11 kV Line Ht.	9.110	11		
548	715430.189	2516744.046	1.752	11 kV Line Ht.	9.110	11		
549	722898.77	2511789.643	1.352	11 kV Line Ht.	9.180	11		
550	716551.527	2515820.459	1.186	11 kV Line Ht.	9.510	11		

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
551	719953.823	2513768.361	1.354	11 kV Line Ht.	9.660	11		
552	715170.184	2516787.836	1.725	11 kV Line Ht.	9.660	11		
553	735711.553	2498591.554	1.895	11 kV Line Ht.	9.770	11		
554	732891.6	2499157.506	1.75	11 kV Line Ht.	9.770	11		
555	732565.614	2499259.179	2.995	11 kV Line Ht.	9.770	11		
556	732322	2499334.797	3.152	11 kV Line Ht.	9.850	11		
557	731088.397	2500325.001	2.754	11 kV Line Ht.	9.850	11		
558	720557.649	2513362.649	1.245	11 kV Line Ht.	9.850	11		
559	720555.457	2513364.121	1.285	11 kV Line Ht.	9.850	11		
560	733116.852	2499087.251	2.932	11 kV Line Ht.	9.850	11		
561	716101.93	2516239.073	2.125	11 kV Line Ht.	9.850	11		
562	716180.017	2516166.366	2.325	Brick Field				
563	716112.668	2516229.074	2.125	Brick Field				
564	716079.786	2516259.69	2.269	Brick Field				
565	732955.318	2499137.633	2.587	Boundary Wall		18		
566	732900.393	2499154.763	1.574	Ditch		70		
567	732893.799	2499156.82	1.535	Ditch		70		
568	726395.896	2507315.623	1.485	Ditch		70		
569	726399.954	2507307.351	1.587	Ditch		70		
570	720606.29	2513329.967	1.432	Ditch		70		
571	720615.031	2513324.093	1.395	Ditch		70		
572	720641.405	2513306.296	1.251	Ditch		70		
573	720635.636	2513310.249	0.214	Ditch		70		
574	720630.85	2513313.465	-1.251	Ditch		70		
575	720625.663	2513316.95	0.262	Ditch		70		
576	720620.781	2513320.23	1.352	Ditch		70		
577	720612.967	2513325.48	0.875	Ditch		70		
578	720610.654	2513327.035	-0.215	Ditch		70		
579	720608.415	2513328.539	0.595	Ditch		70		
580	733511.883	2499036.39	1.621	Drain		30		
581	733510.129	2499036.879	1.601	Drain		30		
582	733117.438	2499087.069	2.895	HBB Road		65		
583	733114.569	2499087.963	2.921	HBB Road		65		
584	719900.698	2513804.056	2.701	HBB Road		65		
585	719903.449	2513802.208	2.754	HBB Road		65		
586	730462.918	2500881.475	2.125	High Land				
587	730116.985	2501189.243	1.955	High Land				
588	730467.227	2500877.642	2.153	High Land				
589	730120.01	2501186.552	1.954	High Land				
590	715531.767	2516718.252	1.932	High Land				
591	715536.547	2516717.038	1.895	High Land				
592	735842.59	2498510.855	2.496	Homestead Area		6		
593	735720.322	2498586.153	2.532	Homestead Area		6		
594	732534.26	2499268.899	2.695	Homestead Area		6		
595	733196.518	2499065.783	2.685	Homestead Area		6		
596	732860.121	2499167.324	2.754	Homestead Area		6		
597	720693.609	2513271.297	2.754	Homestead Area		6		
598	719967.059	2513759.468	2.752	Homestead Area		6		
599	719960.583	2513763.819	2.785	Homestead Area		6		
600	719937.209	2513779.524	2.785	Homestead Area		6		
601	719933.905	2513781.744	2.785	Homestead Area		6		
602	719869.397	2513825.087	2.589	Homestead Area		6		
603	734983.72	2498900.192	2.754	Earthen Road		65		
604	734979.491	2498900.584	2.765	Earthen Road		65		
605	734754.139	2498921.446	2.784	Earthen Road		65		
606	734748.251	2498921.991	2.794	Earthen Road		65		
607	732784.643	2499190.865	2.895	Earthen Road		65		
608	732780.479	2499192.164	2.932	Earthen Road		65		
609	732696.289	2499218.422	2.794	Earthen Road		65		
610	732692.256	2499219.68	2.813	Earthen Road		65		
611	732566.979	2499258.753	2.952	Earthen Road		65		
612	732564.022	2499259.675	2.962	Earthen Road		65		
613	731756.722	2499730.408	2.754	Earthen Road		65		
614	731779.018	2499710.572	2.562	Earthen Road		65		
615	731776.12	2499713.15	2.596	Earthen Road		65		
616	731761.895	2499725.805	2.768	Earthen Road		65		
617	728095.599	2503850.321	2.786	Earthen Road		65		
618	728496.702	2503032.488	2.654	Earthen Road		65		
619	728498.147	2503029.632	2.641	Earthen Road		65		
620	728425.55	2503177.628	2.954	Earthen Road		65		
621	728427.653	2503173.339	2.968	Earthen Road		65		
622	728239.178	2503557.597	2.702	Earthen Road		65		
623	728240.791	2503554.309	2.754	Earthen Road		65		
624	728097.071	2503847.321	2.754	Earthen Road		65		
625	726400.173	2507306.905	2.83	Earthen Road		65		
626	726401.412	2507304.378	2.875	Earthen Road		65		
627	726278.167	2507555.647	2.754	Earthen Road		65		
628	726276.43	2507559.187	2.701	Earthen Road		65		
629	726182.064	2507752.436	2.784	Earthen Road		65		

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630	726179.728	2507756.341	2.754	Earthen Road		65		
631	725683.416	2508768.207	2.721	Earthen Road		65		
632	725684.806	2508765.373	2.685	Earthen Road		65		
633	725160.491	2509834.331	2.731	Earthen Road		65		
634	725161.817	2509831.627	2.784	Earthen Road		65		
635	723649.034	2511285.538	2.864	Earthen Road		65		
636	723646.183	2511287.454	2.845	Earthen Road		65		
637	722903.218	2511786.654	2.684	Earthen Road		65		
638	722899.951	2511788.849	2.721	Earthen Road		65		
639	722847.286	2511824.235	2.954	Earthen Road		65		
640	722844.578	2511826.054	2.912	Earthen Road		65		
641	720602.5	2513332.513	2.452	Earthen Road		65		
642	720605.157	2513330.728	2.485	Earthen Road		65		
643	720508.187	2513395.882	2.654	Earthen Road		65		
644	720505.436	2513397.731	2.612	Earthen Road		65		
645	719929.525	2513784.687	2.395	Earthen Road		65		
646	719932.299	2513782.823	2.365	Earthen Road		65		
647	718000.175	2514471.644	2.954	Earthen Road		65		
648	718977.898	2513987.528	2.921	Earthen Road		65		
649	718974.222	2513987.914	2.869	Earthen Road		65		
650	718025.067	2514448.468	2.854	Earthen Road		65		
651	718022.792	2514450.585	2.895	Earthen Road		65		
652	718002.828	2514469.174	2.921	Earthen Road		65		
653	717204.308	2515212.665	2.985	Earthen Road		65		
654	717206.788	2515210.355	2.958	Earthen Road		65		
655	716307.265	2516047.888	2.957	Earthen Road		65		
656	716309.898	2516045.436	2.958	Earthen Road		65		
657	716104.484	2516236.694	2.921	Earthen Road		65		
658	716108.641	2516232.824	2.874	Earthen Road		65		
659	715487.898	2516729.392	2.995	Earthen Road		65		
660	715484.883	2516730.157	2.985	Earthen Road		65		
661	735645.434	2498632.273	1.452	Canal		75		
662	735639.568	2498635.885	0.354	Canal		75		
663	735631.965	2498640.567	-1.574	Canal		75		
664	735624.138	2498645.388	-1.594	Canal		75		
665	735617.297	2498649.6	0.421	Canal		75		
666	735613.452	2498651.968	1.484	Canal		75		
667	735470.445	2498740.039	1.421	Canal		75		
668	735462.473	2498744.948	1.484	Canal		75		
669	735464.699	2498743.577	0.695	Canal		75		
670	735467.703	2498741.727	0.68	Canal		75		
671	735423.531	2498769.397	1.421	Canal		75		
672	735415.988	2498773.576	1.484	Canal		75		
673	735417.576	2498772.598	0.695	Canal		75		
674	735420.581	2498770.747	0.68	Canal		75		
675	731644.403	2499830.336	1.321	Canal		75		
676	730858.731	2500529.329	1.365	Canal		75		
677	730672.571	2500694.952	1.425	Canal		75		
678	729701.888	2501558.546	1.265	Canal		75		
679	729668.755	2501588.023	1.185	Canal		75		
680	731775.604	2499713.609	1.321	Canal		75		
681	731762.78	2499725.019	1.295	Canal		75		
682	731773.885	2499715.138	0.695	Canal		75		
683	731771.066	2499717.647	-1.695	Canal		75		
684	731768.932	2499719.544	-1.652	Canal		75		
685	731765.6	2499722.509	0.584	Canal		75		
686	731643.099	2499831.496	0.652	Canal		75		
687	731641.298	2499833.098	0.584	Canal		75		
688	731639.515	2499834.685	1.254	Canal		75		
689	730850.503	2500536.65	1.176	Canal		75		
690	730852.856	2500534.556	1.176	Canal		75		
691	730855.231	2500532.443	1.176	Canal		75		
692	730857.171	2500530.717	0.542	Canal		75		
693	730663.16	2500703.324	1.362	Canal		75		
694	730664.892	2500701.784	0.512	Canal		75		
695	730668.64	2500698.449	-1.685	Canal		75		
696	730670.785	2500696.541	0.542	Canal		75		
697	730666.896	2500700.001	-1.721	Canal		75		
698	729689.531	2501569.539	1.321	Canal		75		
699	729692.186	2501567.178	0.321	Canal		75		
700	729694.938	2501564.729	-1.385	Canal		75		
701	729696.956	2501562.933	-1.362	Canal		75		
702	729699.289	2501560.858	0.251	Canal		75		
703	729677.837	2501579.943	1.254	Canal		75		
704	729675.615	2501581.92	0.254	Canal		75		
705	729673.24	2501584.033	-1.654	Canal		75		
706	729670.83	2501586.177	0.312	Canal		75		
707	727417.742	2505232.316	1.321	Canal		75		
708	726491.865	2507119.966	1.265	Canal		75		

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
709	726502.689	2507097.898	1.179	Canal		75		
710	728094.517	2503852.528	1.265	Canal		75		
711	728088.833	2503864.115	1.325	Canal		75		
712	728089.932	2503861.875	0.395	Canal		75		
713	728091.311	2503859.064	-1.625	Canal		75		
714	728092.627	2503856.381	-1.584	Canal		75		
715	728093.683	2503854.227	0.362	Canal		75		
716	727411.025	2505246.01	0.251	Canal		75		
717	727403.857	2505260.623	-2.321	Canal		75		
718	727395.546	2505277.569	-2.374	Canal		75		
719	727388.306	2505292.329	0.325	Canal		75		
720	727382.971	2505303.205	1.264	Canal		75		
721	726500.615	2507102.127	0.365	Canal		75		
722	726497.908	2507107.646	-1.985	Canal		75		
723	726495.475	2507112.605	-1.9958	Canal		75		
724	726493.746	2507116.131	0.421	Canal		75		
725	726401.55	2507304.097	1.265	Canal		75		
726	726417.298	2507271.991	1.179	Canal		75		
727	726414.496	2507277.704	0.365	Canal		75		
728	726411.789	2507283.222	-1.985	Canal		75		
729	726408.327	2507290.28	-1.9958	Canal		75		
730	726404.572	2507297.936	0.421	Canal		75		
731	726179.14	2507757.539	1.245	Canal		75		
732	726169.6	2507776.989	1.274	Canal		75		
733	726171.341	2507773.441	0.321	Canal		75		
734	726173.672	2507768.688	-1.387	Canal		75		
735	726175.975	2507763.991	-1.364	Canal		75		
736	726177.886	2507760.097	0.245	Canal		75		
737	724498.431	2510714.826	1.395	Canal		75		
738	723728.053	2511232.445	0.362	Canal		75		
739	722855.17	2511818.938	1.285	Canal		75		
740	722891.87	2511794.279	0.578	Canal		75		
741	721492.735	2512734.362	1.325	Canal		75		
742	719928.951	2513785.073	1.256	Canal		75		
743	724504.385	2510710.826	0.265	Canal		75		
744	724510.109	2510706.98	-2.362	Canal		75		
745	724516.254	2510702.851	-2.325	Canal		75		
746	724522.193	2510698.861	0.214	Canal		75		
747	724526.537	2510695.941	1.354	Canal		75		
748	723733.809	2511228.578	1.485	Canal		75		
749	723721.085	2511237.127	-2.365	Canal		75		
750	723710.029	2511244.555	-2.458	Canal		75		
751	723703.199	2511249.144	0.452	Canal		75		
752	723696.215	2511253.837	1.532	Canal		75		
753	722898.077	2511790.109	1.302	Canal		75		
754	722883.114	2511800.162	-2.365	Canal		75		
755	722872.119	2511807.55	-2.875	Canal		75		
756	722863.709	2511813.2	0.596	Canal		75		
757	721487.649	2512737.779	1.325	Canal		75		
758	721491.571	2512735.144	0.854	Canal		75		
759	721489.234	2512736.714	0.821	Canal		75		
760	719906.402	2513800.223	1.324	Canal		75		
761	719910.21	2513797.665	0.431	Canal		75		
762	719914.561	2513794.741	-1.394	Canal		75		
763	719919.318	2513791.545	-1.356	Canal		75		
764	719925.26	2513787.552	0.356	Canal		75		
765	719681.586	2513913.613	1.365	Canal		75		
766	718672.05	2514019.654	1.485	Canal		75		
767	718713.942	2514015.253	1.521	Canal		75		
768	716280.471	2516072.544	1.596	Canal		75		
769	716195.979	2516151.505	1.547	Canal		75		
770	715782.28	2516536.695	1.574	Canal		75		
771	715849.754	2516473.87	1.574	Canal		75		
772	719663.771	2513915.484	1.385	Canal		75		
773	719666.86	2513915.16	0.357	Canal		75		
774	719671.028	2513914.722	-1.925	Canal		75		
775	719674.818	2513914.324	-1.895	Canal		75		
776	719678.473	2513913.94	0.325	Canal		75		
777	718705.97	2514016.091	0.362	Canal		75		
778	718698.353	2514016.891	-1.985	Canal		75		
779	718687.731	2514018.006	-1.998	Canal		75		
780	718680.628	2514018.752	0.425	Canal		75		
781	718022.305	2514451.039	1.754	Canal		75		
782	718018.54	2514454.544	0.254	Canal		75		
783	718014.44	2514458.362	-1.365	Canal		75		
784	718010.725	2514461.821	-1.547	Canal		75		
785	718006.895	2514465.387	0.365	Canal		75		
786	718003.284	2514468.749	1.658	Canal		75		
787	716267.132	2516085.255	0.562	Canal		75		

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
788	716252.544	2516098.838	-1.752	Canal		75		
789	716238.656	2516111.769	-1.854	Canal		75		
790	716228.089	2516121.608	-1.598	Canal		75		
791	716212.754	2516135.886	0.365	Canal		75		
792	715861.466	2516462.965	1.602	Canal		75		
793	715858.697	2516465.543	0.215	Canal		75		
794	715856.431	2516467.653	-1.684	Canal		75		
795	715853.641	2516470.251	-1.734	Canal		75		
796	715851.823	2516471.943	0.265	Canal		75		
797	715818.349	2516503.111	1.574	Canal		75		
798	715823.85	2516497.989	1.602	Canal		75		
799	715792.523	2516527.68	1.574	Canal		75		
800	715165.059	2516786.48	3.254	KHULNA SATKHIRA HWY Road		50		
801	715144.529	2516781.051	3.265	KHULNA SATKHIRA HWY Road		50		
802	733014.253	2499119.251	1.621	Low Land		70		
803	733003.813	2499122.508	1.621	Low Land		70		
804	733006.69	2499121.61	1.621	Low Land		70		
805	733010.125	2499120.539	1.621	Low Land		70		
806	730426.177	2500914.163	1.352	Low Land		70		
807	730198.698	2501116.545	1.312	Low Land		70		
808	730039.448	2501258.226	1.295	Low Land		70		
809	730428.045	2500912.501	1.362	Low Land		70		
810	730181.458	2501131.883	1.365	Low Land		70		
811	730195.729	2501119.187	0.854	Low Land		70		
812	730191.984	2501122.519	-1.254	Low Land		70		
813	730188.191	2501125.893	-1.321	Low Land		70		
814	730184.656	2501129.038	0.721	Low Land		70		
815	730114.853	2501191.14	1.265	Low Land		70		
816	730116.707	2501189.491	1.295	Low Land		70		
817	730060.038	2501239.907	1.265	Low Land		70		
818	730055.171	2501244.237	0.595	Low Land		70		
819	730051.709	2501247.318	-1.584	Low Land		70		
820	730043.144	2501254.938	0.621	Low Land		70		
821	730046.987	2501251.519	-1.621	Low Land		70		
822	728244.622	2503546.497	1.265	Low Land		70		
823	724980.638	2510201.01	1.364	Low Land		70		
824	724999.938	2510161.662	1.402	Low Land		70		
825	728241.043	2503553.795	1.295	Low Land		70		
826	728242.434	2503550.958	0.685	Low Land		70		
827	728243.672	2503548.434	0.562	Low Land		70		
828	724984.175	2510193.799	0.74	Low Land		70		
829	724987.974	2510186.053	-1.364	Low Land		70		
830	724992.429	2510176.969	-1.354	Low Land		70		
831	724996.739	2510168.183	0.845	Low Land		70		
832	733165.627	2499072.039	1.874	Pond		80		
833	732874.574	2499162.816	-1.654	Pond		80		
834	733157.382	2499074.61	1.241	Pond		80		
835	733150.642	2499076.713	0.897	Pond		80		
836	733143.432	2499078.961	1.352	Pond		80		
837	733136.318	2499081.18	1.785	Pond		80		
838	732883.858	2499159.921	1.596	Pond		80		
839	732878.301	2499161.654	0.2152	Pond		80		
840	732864.801	2499165.864	0.341	Pond		80		
841	732861.197	2499166.989	1.632	Pond		80		
842	732868.772	2499164.626	-1.695	Pond		80		
843	720756.069	2513229.33	1.485	Pond		80		
844	720669.523	2513287.48	1.325	Pond		80		
845	719874.699	2513821.525	1.256	Pond		80		
846	720748.377	2513234.498	0.587	Pond		80		
847	720739.914	2513240.184	-1.354	Pond		80		
848	720732.369	2513245.254	-1.394	Pond		80		
849	720725.867	2513249.623	0.612	Pond		80		
850	720720.968	2513252.914	1.532	Pond		80		
851	720715.191	2513256.796	1.532	Pond		80		
852	720694.183	2513270.911	1.532	Pond		80		
853	720698.321	2513268.131	0.921	Pond		80		
854	720703.305	2513264.782	-1.954	Pond		80		
855	720707.839	2513261.735	-1.854	Pond		80		
856	720711.859	2513259.034	0.854	Pond		80		
857	720664.662	2513290.747	0.352	Pond		80		
858	720659.191	2513294.422	-1.574	Pond		80		
859	720655.12	2513297.157	-1.625	Pond		80		
860	720651.145	2513299.829	0.452	Pond		80		
861	720648.568	2513301.56	1.302	Pond		80		
862	719898.412	2513805.592	1.214	Pond		80		
863	719894.077	2513808.505	0.652	Pond		80		
864	719888.705	2513812.114	-1.362	Pond		80		
865	719883.199	2513815.813	-1.421	Pond		80		
866	719878.696	2513818.839	0.602	Pond		80		

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
867	732889.143	2499158.272	2.954	Pucca Road		60		
868	732886.068	2499159.231	2.996	Pucca Road		60		
869	732324.418	2499334.406	3.125	Pucca Road		60		
870	732321.534	2499335.306	3.132	Pucca Road		60		
871	731088.447	2500324.956	2.85	Pucca Road		60		
872	731091.081	2500322.613	2.865	Pucca Road		60		
873	729681.447	2501576.731	2.895	Pucca Road		60		
874	729686.501	2501572.235	2.875	Pucca Road		60		
875	727379.795	2505309.681	2.602	Pucca Road		60		
876	727381.208	2505306.8	2.574	Pucca Road		60		
877	723740.657	2511223.977	2.754	Pucca Road		60		
878	723737.696	2511225.966	2.764	Pucca Road		60		
879	732768.734	2499195.827	1.685	River		25		
880	732756.678	2499199.587	-1.365	River		25		
881	732745.853	2499202.964	-2.362	River		25		
882	732738.152	2499205.365	-4.654	River		25		
883	732713.034	2499213.199	-1.654	River		25		
884	732704.849	2499215.752	1.663	River		25		
885	732722.607	2499210.214	-2.364	River		25		
886	732731.034	2499207.585	-4.621	River		25		
887	733131.744	2499082.607	2.754	Semipucca	5	6		
888	733119.149	2499086.535	2.754	Semipucca	5	6		
889	733105.296	2499090.856	2.754	Semipucca	5	6		
890	733114.099	2499088.11	2.754	Semipucca	5	6		
891	732542.586	2499266.361	2.852	Tinshed	5	6		
892	732557.169	2499261.813	2.852	Tinshed	5	6		
893	735842.59	2498510.855	2.496	Tree	12.85	44		
894	735720.322	2498586.153	2.532	Tree	13.66	44		
895	732534.26	2499268.899	2.695	Tree	13.25	44		
896	733196.518	2499065.783	2.685	Tree	14.25	44		
897	732860.121	2499167.324	2.754	Tree	13.25	44		
898	720693.609	2513271.297	2.754	Tree	14.25	44		
899	719967.059	2513759.468	2.752	Tree	12.365	44		
900	719960.583	2513763.819	2.785	Tree	15.325	44		
901	719937.209	2513779.524	2.785	Tree	12.356	44		
902	719933.905	2513781.744	2.785	Tree	12.36	44		
903	719869.397	2513825.087	2.589	Tree	12.85	44		
904	734983.72	2498900.192	2.754	Tree	13.66	44		
905	734979.491	2498900.584	2.765	Tree	13.25	44		
906	734754.139	2498921.446	2.784	Tree	14.25	44		
907	734748.251	2498921.991	2.794	Tree	13.25	44		
908	732784.643	2499190.865	2.895	Tree	14.25	44		
909	732780.479	2499192.164	2.932	Tree	12.365	44		
910	732696.289	2499218.422	2.794	Tree	15.325	44		
911	732692.256	2499219.68	2.813	Tree	12.356	44		
912	732566.979	2499258.753	2.952	Tree	12.36	44		
913	732564.022	2499259.675	2.962	Tree	12.85	44		
914	731756.722	2499730.408	2.754	Tree	13.66	44		
915	731779.018	2499710.572	2.562	Tree	13.25	44		
916	731776.12	2499713.15	2.596	Tree	14.25	44		
917	731761.895	2499725.805	2.768	Tree	13.25	44		
918	728095.599	2503850.321	2.786	Tree	14.25	44		
919	728496.702	2503032.488	2.654	Tree	12.365	44		
920	728498.147	2503029.632	2.641	Tree	15.325	44		
921	728425.55	2503177.628	2.954	Tree	12.356	44		
922	728427.653	2503173.339	2.968	Tree	12.36	44		
923	728239.178	2503557.597	2.702	Tree	12.85	44		
924	728240.791	2503554.309	2.754	Tree	13.66	44		
925	728097.071	2503847.321	2.754	Tree	13.25	44		
926	726400.173	2507306.905	2.83	Tree	14.25	44		
927	726401.412	2507304.378	2.875	Tree	13.25	44		
928	726278.167	2507555.647	2.754	Tree	14.25	44		
929	726276.43	2507559.187	2.701	Tree	12.365	44		
930	726182.064	2507752.436	2.784	Tree	15.325	44		
931	726179.728	2507756.341	2.754	Tree	12.356	44		
932	725683.416	2508768.207	2.721	Tree	12.36	44		
933	725684.806	2508765.373	2.685	Tree	12.85	44		
934	725160.491	2509834.331	2.731	Tree	13.66	44		
935	725161.817	2509831.627	2.784	Tree	13.25	44		
936	723649.034	2511285.538	2.864	Tree	14.25	44		
937	723646.183	2511287.454	2.845	Tree	13.25	44		
938	722903.218	2511786.654	2.684	Tree	14.25	44		
939	722899.951	2511788.849	2.721	Tree	12.365	44		
940	722847.286	2511824.235	2.954	Tree	15.325	44		
941	722844.578	2511826.054	2.912	Tree	12.356	44		
942	720602.5	2513332.513	2.452	Tree	12.36	44		
943	720605.157	2513330.728	2.485	Tree	12.85	44		
944	720508.187	2513395.882	2.654	Tree	13.66	44		
945	720505.436	2513397.731	2.612	Tree	13.25	44		

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
946	719929.525	2513784.687	2.395	Tree	14.25	44		
947	719932.299	2513782.823	2.365	Tree	13.25	44		
948	718000.175	2514471.644	2.954	Tree	14.25	44		
949	718977.898	2513987.528	2.921	Tree	12.365	44		
950	718974.222	2513987.914	2.869	Tree	15.325	44		
951	718025.067	2514448.468	2.854	Tree	12.356	44		
952	718022.792	2514450.585	2.895	Tree	12.36	44		
953	718002.828	2514469.174	2.921	Tree	12.85	44		
954	717204.308	2515212.665	2.985	Tree	13.66	44		
955	717206.788	2515210.355	2.958	Tree	13.25	44		
956	716307.265	2516047.888	2.957	Tree	14.25	44		
957	716309.898	2516045.436	2.958	Tree	13.25	44		
958	716104.484	2516236.694	2.921	Tree	14.25	44		
959	716108.641	2516232.824	2.874	Tree	12.365	44		
960	715487.898	2516729.392	2.995	Tree	15.325	44		
961	715484.883	2516730.157	2.985	Tree	12.356	44		

Bhandaria-Mathbaria132kV Double Circuit Line								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1	187879.4479	2461639.873	1.523	Proposed Gentry (Mathbaria)		101		
2	187985.7498	2461629.376	1.302	TT-01		101	39°7'42" LT	
3	188720.3885	2462115.412	1.254	AP No.-01		101	38°47'42" LT	
4	189387.4162	2464203.414	1.263	AP No.-02		101	11°53'48" RT	
5	190628.8664	2466387.587	1.295	AP No.-03		101	18°26'12" LT	
6	190998.8703	2468260.247	1.263	AP No.-04		101	14°53'18"LT	
7	190960.2213	2468856.013	1.302	AP No.-05		101	37°52'12" RT	
8	191671.2942	2469903.968	1.362	AP No.-06		101	9°41'36"LT	
9	192512.4379	2471752.696	1.221	AP No.-07		101	12°18'22" RT	
10	192952.6865	2472341.812	1.262	AP No.-08		101	21°55'28" LT	
11	193280.8681	2473579.87	1.185	AP No.-09		101	18°26'9" RT	
12	193543.9789	2473980.687	0.784	AP No.-10		101	31°20'49" LT	
13	193591.4116	2475386.156	0.574	AP No.-11		101	35°26'14" RT	
14	194291.903	2476303.186	0.294	AP No.-12		101	38°47'9" LT	
15	194243.9373	2478248.344	0.132	AP No.-13		101	6°19'41" LT	
16	194105.5335	2479266.486	0.854	AP No.-14		101	35°30'28" RT	
17	194655.1294	2480310.413	0.865	AP No.-15		101	35°19'29" LT	
18	194438.8894	2481940.577	1.13	AP No.-16		101	58°57'33" RT	
19	195820.6212	2482997.647	1.285	AP No.-17		101	19°30'25" LT	
20	196255.0105	2483625.69	1.362	AP No.-18		101	27°14'57" RT	
21	197135.5441	2484095.419	1.365	AP No.-19		101	53°20'24" LT	
22	197352.0664	2485530.619	1.393	AP No.-20		101	12°29'56" LT	
23	197268.9613	2486698.33	1.521	AP No.-21		101	59°15'35"RT	
24	198373.009	2487352.363	1.635	AP No- 22		101	40°33'39"LT	
25	198497.648	2487718.553	1.685	AP No- 23		101	21°54'52"LT	
26	198479.4139	2488053.34	1.721	AP No- 24		101	11°30'24" RT	
27	198486.000	2488098.000	2.29	Pirojpur-Bhandaria AP- 40		101	53°23'31" RT	
28	198593.410	2488710.650	2.26	Pirojpur-Bhandaria AP- 41		101	54°06'05" LT	
29	198438.0123	2488870.678	1.84	Existing TT- 02 (4-ckt)		101	51°25'30" RT	
30	198448.24	2488950.19	1.63	Gantry (Bhandaria)		101		
31	198439.127	2488932.196	1.951	RL		200		
32	198443.774	2488850.102	1.731	RL		200		
33	198483.327	2488819.515	1.728	RL		200		
34	198495.067	2488699.519	1.701	RL		200		
35	198448.085	2488682.411	1.696	RL		200		
36	198302.743	2488438.538	1.681	RL		200		
37	198284.065	2488392.158	1.676	RL		200		
38	198290.627	2488345.296	1.672	RL		200		
39	198307.52	2488298.236	1.668	RL		200		
40	198324.414	2488251.176	1.675	RL		200		
41	198341.307	2488204.116	1.669	RL		200		
42	198358.2	2488157.057	1.665	RL		200		
43	198375.093	2488109.997	1.661	RL		200		
44	198391.987	2488062.937	1.655	RL		200		
45	198408.88	2488015.878	1.653	RL		200		
46	198425.773	2487968.818	1.651	RL		200		
47	198442.667	2487921.758	1.648	RL		200		
48	198459.56	2487874.699	1.645	RL		200		
49	198476.453	2487827.639	1.635	RL		200		
50	198490.942	2487780.488	1.631	RL		200		
51	198477.663	2487732.283	1.633	RL		200		
52	198464.384	2487684.079	1.631	RL		200		
53	198451.106	2487635.874	1.638	RL		200		
54	198437.827	2487587.67	1.629	RL		200		
55	198424.549	2487539.465	1.628	RL		200		
56	198411.27	2487491.26	1.625	RL		200		
57	198397.992	2487443.056	1.622	RL		200		
58	198384.713	2487394.851	1.621	RL		200		
59	198367.907	2487349.341	1.619	RL		200		
60	198324.889	2487323.857	1.613	RL		200		
61	198281.871	2487298.374	1.611	RL		200		
62	198238.853	2487272.89	1.601	RL		200		
63	198195.834	2487247.406	1.595	RL		200		
64	198152.816	2487221.922	1.591	RL		200		
65	198098.339	2487189.65	1.588	RL		200		
66	198062.877	2487168.642	1.875	RL		200		
67	198023.761	2487145.47	1.585	RL		200		
68	197980.743	2487119.986	1.583	RL		200		
69	197937.725	2487094.503	1.581	RL		200		
70	197887.89	2487064.981	1.578	RL		200		
71	197765.652	2486992.567	1.57	RL		200		
72	197722.633	2486967.083	1.568	RL		200		
73	197679.615	2486941.599	1.565	RL		200		
74	197421.505	2486788.696	1.56	RL		200		

Bhandaria-Mathbaria132kV Double Circuit Line								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
75	197378.487	2486763.212	1.552	RL		200		
76	197335.469	2486737.728	1.55	RL		200		
77	197292.451	2486712.244	1.451	RL		200		
78	197291.87	2486376.445	1.437	RL		200		
79	197295.419	2486326.571	1.433	RL		200		
80	197298.969	2486276.697	1.431	RL		200		
81	197327.364	2485877.707	1.419	RL		200		
82	197330.914	2485827.833	1.415	RL		200		
83	197334.463	2485777.959	1.411	RL		200		
84	197338.013	2485728.085	1.408	RL		200		
85	197341.562	2485678.211	1.399	RL		200		
86	197345.112	2485628.337	1.398	RL		200		
87	197348.661	2485578.463	1.395	RL		200		
88	197351.763	2485528.607	1.393	RL		200		
89	197344.304	2485479.167	1.391	RL		200		
90	197336.845	2485429.726	1.389	RL		200		
91	197314.468	2485281.405	1.383	RL		200		
92	197307.01	2485231.964	1.381	RL		200		
93	197299.551	2485182.524	1.379	RL		200		
94	197292.092	2485133.083	1.378	RL		200		
95	197284.633	2485083.643	1.374	RL		200		
96	197277.174	2485034.202	1.371	RL		200		
97	197269.715	2484984.762	1.369	RL		200		
98	197262.256	2484935.321	1.365	RL		200		
99	197239.88	2484786.999	1.363	RL		200		
100	197232.421	2484737.559	1.361	RL		200		
101	197202.585	2484539.797	1.353	RL		200		
102	197195.127	2484490.356	1.351	RL		200		
103	197187.668	2484440.916	1.348	RL		200		
104	197180.209	2484391.475	1.343	RL		200		
105	197172.75	2484342.035	1.341	RL		200		
106	197165.291	2484292.594	1.338	RL		200		
107	197157.832	2484243.154	1.333	RL		200		
108	197150.373	2484193.713	1.331	RL		200		
109	197142.914	2484144.273	1.328	RL		200		
110	197127.164	2484090.97	1.325	RL		200		
111	197090.889	2484071.616	1.321	RL		200		
112	197046.775	2484048.08	1.319	RL		200		
113	197006.512	2484026.599	1.315	RL		200		
114	196958.546	2484001.009	1.308	RL		200		
115	196914.432	2483977.473	1.296	RL		200		
116	196870.318	2483953.937	1.295	RL		200		
117	196826.203	2483930.401	1.291	RL		200		
118	196782.089	2483906.865	1.289	RL		200		
119	196737.975	2483883.329	1.286	RL		200		
120	196693.861	2483859.794	1.282	RL		200		
121	196649.747	2483836.258	1.279	RL		200		
122	196605.632	2483812.722	1.275	RL		200		
123	196561.518	2483789.186	1.273	RL		200		
124	196517.404	2483765.65	1.271	RL		200		
125	196473.29	2483742.114	1.268	RL		200		
126	196429.175	2483718.579	1.265	RL		200		
127	196385.061	2483695.043	1.262	RL		200		
128	196340.947	2483671.507	1.261	RL		200		
129	196296.833	2483647.971	1.259	RL		200		
130	196249.269	2483617.389	1.257	RL		200		
131	195940.654	2483171.192	1.232	RL		200		
132	195855.327	2483047.825	1.228	RL		200		
133	195826.885	2483006.703	1.225	RL		200		
134	195789.023	2482974.813	1.218	RL		200		
135	195748.481	2482945.549	1.212	RL		200		
136	195707.94	2482916.285	1.21	RL		200		
137	195618.185	2482851.496	1.198	RL		200		
138	195586.316	2482828.492	1.195	RL		200		
139	195545.774	2482799.228	1.193	RL		200		
140	195505.233	2482769.963	1.191	RL		200		
141	195469.753	2482744.352	1.402	RL		200		
142	195424.15	2482711.435	1.186	RL		200		
143	195383.609	2482682.17	1.185	RL		200		
144	195343.068	2482652.906	1.181	RL		200		
145	195302.526	2482623.642	1.179	RL		200		
146	195261.985	2482594.378	1.176	RL		200		
147	195221.444	2482565.113	1.173	RL		200		
148	195182.302	2482534.006	1.171	RL		200		

Bhandaria-Mathbaria132kV Double Circuit Line								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
149	195143.225	2482502.813	1.169	RL		200		
150	195104.148	2482471.62	1.167	RL		200		
151	195065.071	2482440.427	1.165	RL		200		
152	195025.994	2482409.234	1.162	RL		200		
153	194986.918	2482378.041	1.16	RL		200		
154	194947.841	2482346.848	1.158	RL		200		
155	194908.764	2482315.655	1.155	RL		200		
156	194869.687	2482284.462	1.151	RL		200		
157	194830.611	2482253.269	1.148	RL		200		
158	194791.534	2482222.076	1.143	RL		200		
159	194752.457	2482190.883	1.141	RL		200		
160	194439.843	2481941.338	1.13	RL		200		
161	194445.305	2481892.221	1.128	RL		200		
162	194458.458	2481793.09	1.105	RL		200		
163	194465.035	2481743.524	0.996	RL		200		
164	194471.611	2481693.959	0.992	RL		200		
165	194478.187	2481644.393	0.988	RL		200		
166	194484.764	2481594.827	0.985	RL		200		
167	194491.34	2481545.262	0.981	RL		200		
168	194504.493	2481446.13	0.915	RL		200		
169	194511.069	2481396.565	0.925	RL		200		
170	194517.646	2481346.999	0.92	RL		200		
171	194524.415	2481295.978	0.915	RL		200		
172	194530.799	2481247.868	0.91	RL		200		
173	194543.951	2481148.737	0.899	RL		200		
174	194550.528	2481099.171	0.895	RL		200		
175	194557.104	2481049.605	0.893	RL		200		
176	194563.681	2481000.04	0.891	RL		200		
177	194589.986	2480801.777	0.877	RL		200		
178	194596.563	2480752.212	0.873	RL		200		
179	194603.139	2480702.646	0.871	RL		200		
180	194616.292	2480603.515	0.863	RL		200		
181	194622.868	2480553.949	0.861	RL		200		
182	194629.445	2480504.384	0.858	RL		200		
183	194636.021	2480454.818	0.855	RL		200		
184	194642.597	2480405.252	0.852	RL		200		
185	194649.174	2480355.687	0.849	RL		200		
186	194653.182	2480306.579	0.845	RL		200		
187	194513.42	2480041.123	0.921	RL		200		
188	194490.126	2479996.881	0.915	RL		200		
189	194473.022	2479964.395	0.911	RL		200		
190	194443.539	2479908.396	0.901	RL		200		
191	194396.952	2479819.91	0.892	RL		200		
192	194373.658	2479775.668	0.889	RL		200		
193	194350.364	2479731.425	0.885	RL		200		
194	194327.071	2479687.183	0.883	RL		200		
195	194280.483	2479598.697	0.869	RL		200		
196	194140.722	2479333.242	0.825	RL		200		
197	194117.428	2479288.999	0.815	RL		200		
198	194108.84	2479242.16	0.8	RL		200		
199	194115.575	2479192.616	0.85	RL		200		
200	194122.31	2479143.072	0.89	RL		200		
201	194129.045	2479093.527	0.92	RL		200		
202	194135.78	2479043.983	0.95	RL		200		
203	194142.515	2478994.439	0.97	RL		200		
204	194149.25	2478944.894	0.102	RL		200		
205	194155.985	2478895.35	0.11	RL		200		
206	194162.72	2478845.806	0.113	RL		200		
207	194176.19	2478746.717	0.115	RL		200		
208	194196.394	2478598.084	0.125	RL		200		
209	194203.129	2478548.54	0.128	RL		200		
210	194223.334	2478399.907	0.133	RL		200		
211	194230.069	2478350.362	0.134	RL		200		
212	194236.804	2478300.818	0.136	RL		200		
213	194243.539	2478251.274	0.139	RL		200		
214	194245.1	2478201.315	0.141	RL		200		
215	194252.499	2477901.406	0.143	RL		200		
216	194253.732	2477851.422	0.148	RL		200		
217	194254.965	2477801.437	0.151	RL		200		
218	194256.199	2477751.452	0.153	RL		200		
219	194257.432	2477701.467	0.157	RL		200		
220	194259.898	2477601.498	0.161	RL		200		
221	194261.131	2477551.513	0.163	RL		200		
222	194262.364	2477501.528	0.166	RL		200		

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SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
223	194264.83	2477401.559	0.173	RL		200		
224	194266.064	2477351.574	0.177	RL		200		
225	194269.763	2477201.619	0.384	RL		200		
226	194272.229	2477101.65	0.365	RL		200		
227	194273.462	2477051.665	0.259	RL		200		
228	194274.695	2477001.68	0.263	RL		200		
229	194275.929	2476951.695	0.266	RL		200		
230	194277.162	2476901.711	0.269	RL		200		
231	194278.395	2476851.726	0.27	RL		200		
232	194279.628	2476801.741	0.272	RL		200		
233	194280.861	2476751.756	0.273	RL		200		
234	194282.094	2476701.771	0.275	RL		200		
235	194283.327	2476651.787	0.277	RL		200		
236	194284.56	2476601.802	0.279	RL		200		
237	194285.794	2476551.817	0.283	RL		200		
238	194287.027	2476501.832	0.285	RL		200		
239	194288.26	2476451.847	0.289	RL		200		
240	194291.123	2476302.164	0.294	RL		200		
241	194230.423	2476222.694	0.299	RL		200		
242	194200.074	2476182.959	0.31	RL		200		
243	194169.724	2476143.223	0.315	RL		200		
244	194109.024	2476063.753	0.411	RL		200		
245	194048.325	2475984.282	0.431	RL		200		
246	194017.975	2475944.547	0.436	RL		200		
247	193987.625	2475904.812	0.441	RL		200		
248	193957.275	2475865.077	0.445	RL		200		
249	193926.926	2475825.341	0.449	RL		200		
250	193896.576	2475785.606	0.452	RL		200		
251	193866.226	2475745.871	0.455	RL		200		
252	193835.876	2475706.136	0.458	RL		200		
253	193805.526	2475666.4	0.461	RL		200		
254	193775.177	2475626.665	0.463	RL		200		
255	193744.827	2475586.93	0.466	RL		200		
256	193714.477	2475547.195	0.469	RL		200		
257	193684.127	2475507.459	0.472	RL		200		
258	193653.777	2475467.724	0.476	RL		200		
259	193623.428	2475427.989	0.479	RL		200		
260	193589.875	2475338.823	0.481	RL		200		
261	193588.186	2475288.852	0.485	RL		200		
262	193583.12	2475138.937	0.491	RL		200		
263	193581.431	2475088.966	0.505	RL		200		
264	193576.365	2474939.051	0.765	RL		200		
265	193574.676	2474889.08	0.526	RL		200		
266	193569.61	2474739.165	0.536	RL		200		
267	193567.922	2474689.194	0.541	RL		200		
268	193566.233	2474639.222	0.544	RL		200		
269	193564.544	2474589.251	0.548	RL		200		
270	193562.856	2474539.279	0.551	RL		200		
271	193559.478	2474439.337	0.562	RL		200		
272	193557.789	2474389.365	0.571	RL		200		
273	193556.101	2474339.394	0.573	RL		200		
274	193554.412	2474289.422	0.579	RL		200		
275	193552.723	2474239.451	0.585	RL		200		
276	193551.035	2474189.479	0.591	RL		200		
277	193549.346	2474139.508	0.593	RL		200		
278	193547.657	2474089.536	0.598	RL		200		
279	193545.969	2474039.565	0.625	RL		200		
280	193544.537	2473997.195	0.657	RL		200		
281	193521.431	2473946.338	0.689	RL		200		
282	193493.992	2473904.539	0.763	RL		200		
283	193466.554	2473862.74	0.842	RL		200		
284	193301.925	2473611.947	1.151	RL		200		
285	193277.889	2473568.629	1.153	RL		200		
286	193265.077	2473520.298	1.155	RL		200		
287	193252.266	2473471.967	1.157	RL		200		
288	193239.454	2473423.637	1.159	RL		200		
289	193226.643	2473375.306	1.161	RL		200		
290	193213.831	2473326.975	1.163	RL		200		
291	193201.02	2473278.644	1.164	RL		200		
292	193188.209	2473230.313	1.168	RL		200		
293	193175.397	2473181.983	1.17	RL		200		
294	193162.586	2473133.652	1.172	RL		200		
295	193149.774	2473085.321	1.174	RL		200		
296	193136.963	2473036.99	1.177	RL		200		

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SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
297	193124.151	2472988.659	1.179	RL		200		
298	193111.34	2472940.329	1.182	RL		200		
299	193098.529	2472891.998	1.185	RL		200		
300	193085.717	2472843.667	1.188	RL		200		
301	193072.906	2472795.336	1.192	RL		200		
302	193060.094	2472747.005	1.195	RL		200		
303	193047.283	2472698.674	1.198	RL		200		
304	193034.471	2472650.344	1.201	RL		200		
305	193021.66	2472602.013	1.209	RL		200		
306	193008.849	2472553.682	1.211	RL		200		
307	192996.037	2472505.351	1.215	RL		200		
308	192970.414	2472408.69	1.219	RL		200		
309	192934.242	2472317.13	1.225	RL		200		
310	192904.311	2472277.078	1.231	RL		200		
311	192874.38	2472237.026	1.227	RL		200		
312	192844.449	2472196.975	1.225	RL		200		
313	192814.518	2472156.923	1.223	RL		200		
314	192784.587	2472116.871	1.221	RL		200		
315	192754.657	2472076.819	1.219	RL		200		
316	192724.726	2472036.768	1.217	RL		200		
317	192607.245	2471879.562	1.298	RL		200		
318	192575.071	2471836.509	1.225	RL		200		
319	192545.141	2471796.457	1.223	RL		200		
320	192515.21	2471756.405	1.221	RL		200		
321	192493.649	2471711.4	1.217	RL		200		
322	192472.942	2471665.889	1.215	RL		200		
323	192452.235	2471620.378	1.213	RL		200		
324	192431.529	2471574.868	1.211	RL		200		
325	192410.822	2471529.357	1.213	RL		200		
326	192395.921	2471496.607	1.385	RL		200		
327	192369.408	2471438.335	1.219	RL		200		
328	192348.702	2471392.824	1.221	RL		200		
329	192327.995	2471347.314	1.225	RL		200		
330	192307.288	2471301.803	1.228	RL		200		
331	192286.581	2471256.292	1.23	RL		200		
332	192265.875	2471210.781	1.232	RL		200		
333	192245.168	2471165.271	1.235	RL		200		
334	192203.755	2471074.249	1.239	RL		200		
335	192183.048	2471028.738	1.241	RL		200		
336	192162.341	2470983.227	1.245	RL		200		
337	192141.634	2470937.717	1.248	RL		200		
338	192120.928	2470892.206	1.251	RL		200		
339	192100.221	2470846.695	1.255	RL		200		
340	192079.514	2470801.184	1.257	RL		200		
341	192058.808	2470755.674	1.262	RL		200		
342	192038.101	2470710.163	1.264	RL		200		
343	192017.394	2470664.652	1.269	RL		200		
344	191996.687	2470619.141	1.271	RL		200		
345	191975.981	2470573.63	1.273	RL		200		
346	191955.274	2470528.12	1.275	RL		200		
347	191934.567	2470482.609	1.279	RL		200		
348	191913.86	2470437.098	1.281	RL		200		
349	191893.154	2470391.587	1.285	RL		200		
350	191872.447	2470346.076	1.288	RL		200		
351	191851.74	2470300.566	1.391	RL		200		
352	191831.034	2470255.055	1.294	RL		200		
353	191789.62	2470164.033	1.296	RL		200		
354	191768.913	2470118.523	1.306	RL		200		
355	191748.207	2470073.012	1.311	RL		200		
356	191727.5	2470027.501	1.315	RL		200		
357	191706.793	2469981.99	1.318	RL		200		
358	191686.086	2469936.479	1.32	RL		200		
359	191663.275	2469892.15	1.323	RL		200		
360	191635.201	2469850.776	1.325	RL		200		
361	191607.127	2469809.401	1.329	RL		200		
362	191579.053	2469768.027	1.331	RL		200		
363	191550.979	2469726.652	1.333	RL		200		
364	191522.905	2469685.277	1.336	RL		200		
365	191494.831	2469643.903	1.339	RL		200		
366	191466.757	2469602.528	1.341	RL		200		
367	191438.683	2469561.154	1.345	RL		200		
368	191410.609	2469519.779	1.348	RL		200		
369	191382.535	2469478.405	1.352	RL		200		
370	191298.313	2469354.281	1.319	RL		200		

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SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
371	191272.371	2469316.049	1.322	RL		200		
372	191242.165	2469271.532	1.326	RL		200		
373	191214.091	2469230.158	1.333	RL		200		
374	191186.017	2469188.783	1.331	RL		200		
375	191157.943	2469147.409	1.327	RL		200		
376	191129.869	2469106.034	1.324	RL		200		
377	191101.795	2469064.66	1.321	RL		200		
378	191073.721	2469023.285	1.319	RL		200		
379	191045.647	2468981.911	1.315	RL		200		
380	191017.573	2468940.536	1.313	RL		200		
381	190989.499	2468899.162	1.311	RL		200		
382	190961.425	2468857.787	1.301	RL		200		
383	190963.319	2468808.258	1.298	RL		200		
384	190966.556	2468758.362	1.291	RL		200		
385	190969.793	2468708.467	1.288	RL		200		
386	190973.03	2468658.572	1.285	RL		200		
387	190979.503	2468558.782	1.277	RL		200		
388	190982.74	2468508.887	1.274	RL		200		
389	190985.977	2468458.992	1.271	RL		200		
390	190989.214	2468409.097	1.265	RL		200		
391	190992.451	2468359.201	1.261	RL		200		
392	190995.688	2468309.306	1.258	RL		200		
393	190997.402	2468252.814	1.254	RL		200		
394	190989.016	2468210.374	1.251	RL		200		
395	190969.633	2468112.27	1.296	RL		200		
396	190959.941	2468063.218	1.291	RL		200		
397	190950.249	2468014.167	1.288	RL		200		
398	190940.558	2467965.115	1.285	RL		200		
399	190911.482	2467817.96	1.211	RL		200		
400	190892.099	2467719.857	1.221	RL		200		
401	190882.407	2467670.805	1.215	RL		200		
402	190872.715	2467621.753	1.211	RL		200		
403	190853.332	2467523.65	1.214	RL		200		
404	190843.64	2467474.598	1.217	RL		200		
405	190833.948	2467425.546	1.221	RL		200		
406	190824.257	2467376.495	1.225	RL		200		
407	190804.873	2467278.391	1.231	RL		200		
408	190795.182	2467229.339	1.235	RL		200		
409	190785.49	2467180.288	1.237	RL		200		
410	190775.798	2467131.236	1.241	RL		200		
411	190766.106	2467082.184	1.244	RL		200		
412	190756.415	2467033.133	1.248	RL		200		
413	190746.723	2466984.081	1.251	RL		200		
414	190737.031	2466935.029	1.247	RL		200		
415	190727.339	2466885.977	1.242	RL		200		
416	190717.648	2466836.926	1.237	RL		200		
417	190707.956	2466787.874	1.207	RL		200		
418	190698.264	2466738.822	1.211	RL		200		
419	190688.572	2466689.771	1.213	RL		200		
420	190678.881	2466640.719	1.217	RL		200		
421	190669.189	2466591.667	1.219	RL		200		
422	190659.497	2466542.615	1.222	RL		200		
423	190649.806	2466493.564	1.225	RL		200		
424	190640.114	2466444.512	1.228	RL		200		
425	190630.422	2466395.46	1.231	RL		200		
426	190608.125	2466351.095	1.234	RL		200		
427	190577.988	2466298.074	1.238	RL		200		
428	190509.297	2466177.219	1.211	RL		200		
429	190484.589	2466133.75	1.216	RL		200		
430	190459.882	2466090.281	1.225	RL		200		
431	190435.175	2466046.812	1.229	RL		200		
432	190410.468	2466003.343	1.232	RL		200		
433	190385.761	2465959.874	1.239	RL		200		
434	190336.347	2465872.936	1.248	RL		200		
435	190311.639	2465829.467	1.255	RL		200		
436	190286.932	2465785.998	1.251	RL		200		
437	190262.225	2465742.529	1.249	RL		200		
438	190237.518	2465699.06	1.245	RL		200		
439	190212.811	2465655.591	1.242	RL		200		
440	190188.104	2465612.121	1.239	RL		200		
441	190163.397	2465568.652	1.237	RL		200		
442	190138.69	2465525.183	1.233	RL		200		
443	190113.982	2465481.714	1.231	RL		200		
444	190089.275	2465438.245	1.228	RL		200		

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SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
445	190064.568	2465394.776	1.222	RL		200		
446	190039.861	2465351.307	1.658	RL		200		
447	190015.154	2465307.838	1.247	RL		200		
448	189990.447	2465264.369	1.243	RL		200		
449	189965.74	2465220.9	1.241	RL		200		
450	189941.033	2465177.431	1.238	RL		200		
451	189916.325	2465133.962	1.235	RL		200		
452	189891.618	2465090.493	1.232	RL		200		
453	189866.911	2465047.024	1.229	RL		200		
454	189842.204	2465003.555	1.226	RL		200		
455	189817.497	2464960.086	1.222	RL		200		
456	189792.79	2464916.617	1.219	RL		200		
457	189768.083	2464873.148	1.215	RL		200		
458	189743.375	2464829.679	1.261	RL		200		
459	189718.668	2464786.21	1.257	RL		200		
460	189693.961	2464742.741	1.253	RL		200		
461	189669.254	2464699.272	1.25	RL		200		
462	189644.547	2464655.803	1.247	RL		200		
463	189619.84	2464612.333	1.245	RL		200		
464	189595.133	2464568.864	1.241	RL		200		
465	189570.426	2464525.395	1.238	RL		200		
466	189545.718	2464481.926	1.233	RL		200		
467	189521.011	2464438.457	1.231	RL		200		
468	189496.304	2464394.988	1.226	RL		200		
469	189471.597	2464351.519	1.221	RL		200		
470	189446.89	2464308.05	1.217	RL		200		
471	189422.183	2464264.581	1.213	RL		200		
472	189397.476	2464221.112	1.21	RL		200		
473	189378.396	2464175.177	1.208	RL		200		
474	189363.18	2464127.548	1.211	RL		200		
475	189332.75	2464032.291	1.225	RL		200		
476	189317.534	2463984.662	1.221	RL		200		
477	189241.458	2463746.519	1.219	RL		200		
478	189226.242	2463698.89	1.215	RL		200		
479	189211.027	2463651.261	1.211	RL		200		
480	189135.467	2463414.734	1.242	RL		200		
481	189119.735	2463365.489	1.237	RL		200		
482	189104.52	2463317.86	1.233	RL		200		
483	189089.304	2463270.232	1.231	RL		200		
484	189074.089	2463222.603	1.228	RL		200		
485	189058.874	2463174.974	1.225	RL		200		
486	189043.658	2463127.346	1.221	RL		200		
487	189028.443	2463079.717	1.215	RL		200		
488	189013.228	2463032.088	1.211	RL		200		
489	188998.012	2462984.459	1.209	RL		200		
490	188967.581	2462889.202	1.287	RL		200		
491	188952.366	2462841.573	1.285	RL		200		
492	188937.151	2462793.945	1.278	RL		200		
493	188921.935	2462746.316	1.282	RL		200		
494	188906.72	2462698.687	1.286	RL		200		
495	188891.505	2462651.059	1.283	RL		200		
496	188876.289	2462603.43	1.28	RL		200		
497	188861.074	2462555.801	1.277	RL		200		
498	188845.859	2462508.172	1.273	RL		200		
499	188830.643	2462460.544	1.275	RL		200		
500	188815.428	2462412.915	1.272	RL		200		
501	188800.213	2462365.286	1.268	RL		200		
502	188784.997	2462317.658	1.271	RL		200		
503	188769.782	2462270.029	1.274	RL		200		
504	188754.567	2462222.4	1.278	RL		200		
505	188739.351	2462174.771	1.281	RL		200		
506	188724.136	2462127.143	1.288	RL		200		
507	188688.959	2462094.618	1.291	RL		200		
508	188647.259	2462067.03	1.289	RL		200		
509	188605.56	2462039.441	1.284	RL		200		
510	188567.372	2462014.177	1.281	RL		200		
511	188522.16	2461984.264	1.279	RL		200		
512	188480.46	2461956.676	1.275	RL		200		
513	188438.76	2461929.087	1.27	RL		200		
514	188397.061	2461901.499	1.263	RL		200		
515	188355.361	2461873.91	1.259	RL		200		
516	188313.661	2461846.322	1.252	RL		200		
517	188271.961	2461818.733	1.246	RL		200		
518	188230.261	2461791.144	1.241	RL		200		

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SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
519	188188.562	2461763.556	1.238	RL		200		
520	188146.862	2461735.967	1.231	RL		200		
521	188105.162	2461708.379	1.226	RL		200		
522	188063.462	2461680.79	1.221	RL		200		
523	188021.763	2461653.202	1.214	RL		200		
524	187978.964	2461630.046	1.321	RL		200		
525	187935.627	2461634.325	1.42	RL		200		
526	187879.448	2461639.873	1.523	RL		200		
527	189358.456	2464112.76	1.574	RL		200		
528	194266.713	2477325.267	0.425	RL		200		
529	192982.357	2472452.179	1.458	RL		200		
530	193585.049	2475196.033	1.032	RL		200		
531	193584.587	2475182.341	1.021	RL		200		
532	193571.772	2474803.124	0.965	RL		200		
533	193570.955	2474778.972	0.954	RL		200		
534	193561.458	2474497.916	0.695	RL		200		
535	194268.051	2479575.084	0.954	RL		200		
536	194437.793	2479897.483	1.011	RL		200		
537	195906.666	2483122.052	1.385	RL		200		
538	195884	2483089.28	1.354	RL		200		
539	195480.024	2482751.766	1.452	RL		200		
540	197230.129	2484722.368	1.874	RL		200		
541	198137.384	2487212.78	1.765	RL		200		
542	198124.244	2487204.996	1.758	RL		200		
543	198367.651	2488599.704	1.879	RL		200		
544	198362.104	2488585.932	1.874	RL		200		
545	190032.386	2465338.156	1.724	RL		200		
546	191365.895	2469453.881	1.352	RL		200		
547	192221.441	2471113.121	1.356	RL		200		
548	192234.699	2471142.261	1.389	RL		200		
549	193367.404	2473711.697	1.451	RL		200		
550	193417.698	2473788.313	2.325	RL		200		
551	194270.945	2477153.695	0.7985	RL		200		
552	195965.885	2483207.67	1.352	RL		200		
553	197328.412	2485373.831	1.432	RL		200		
554	197602.175	2486895.724	1.521	RL		200		
555	195646.068	2482871.623	1.205	11 kV Line Ht.	9.4	11		
556	194539.503	2481182.261	0.902	11 kV Line Ht.	9.5	11		
557	194609.482	2480654.843	0.866	11 kV Line Ht.	9.5	11		
558	194259.028	2477636.744	0.159	11 kV Line Ht.	9.5	11		
559	190812.245	2467315.7	1.228	11 kV Line Ht.	9.5	11		
560	190353.063	2465902.346	1.241	11 kV Line Ht.	9.5	11		
561	192399.518	2471504.512	3.011	11 kV Line Ht.	9.5	11		
562	194269.359	2477217.979	0.521	11 kV Line Ht.	9.5	11		
563	197312.541	2486085.991	2.754	11 kV Line Ht.	9.6	11		
564	197324.766	2485914.212	1.421	11 kV Line Ht.	9.6	11		
565	192960.773	2472372.316	1.222	11 kV Line Ht.	9.6	11		
566	190975.778	2468616.213	1.281	11 kV Line Ht.	9.6	11		
567	189160.538	2463493.215	2.895	11 kV Line Ht.	9.6	11		
568	189348.267	2464080.866	2.701	11 kV Line Ht.	9.6	11		
569	190978.512	2468157.208	1.352	11 kV Line Ht.	9.6	11		
570	191281.412	2469329.372	1.595	11 kV Line Ht.	9.6	11		
571	191315.414	2469379.483	1.285	11 kV Line Ht.	9.6	11		
572	195971.661	2483216.022	1.395	11 kV Line Ht.	9.6	11		
573	196024.532	2483292.463	0.251	11 kV Line Ht.	9.6	11		
574	196199.751	2483545.796	2.301	11 kV Line Ht.	9.6	11		
575	197554.978	2486867.765	2.457	11 kV Line Ht.	9.6	11		
576	197541.244	2486859.629	2.232	11 kV Line Ht.	9.6	11		
577	197579.361	2486882.209	3.521	11 kV Line Ht.	9.6	11		
578	193586.175	2475229.345	0.487	11 kV Line Ht.	9.8	11		
579	193359.199	2473699.197	1.352	11 kV Line Ht.	9.8	11		
580	188983.666	2462939.551	1.458	11 kV Line Ht.	9.8	11		
581	193570.262	2474758.456	0.785	11 kV Line Ht.	9.8	11		
582	198332.728	2488480.989	3.021	1-Std. Building	6	6		
583	198339.361	2488478.949	3.021	1-Std. Building	6	6		
584	198336.492	2488469.294	3.021	1-Std. Building	6	6		
585	198354.277	2488602.072	3.421	1-Std. Building	6	6		
586	198356.704	2488613.568	3.421	1-Std. Building	6	6		
587	198345.876	2488616.196	3.421	1-Std. Building	6	6		
588	198385.566	2488603.938	3.421	1-Std. Building	6	6		
589	198384.029	2488596.185	3.421	1-Std. Building	6	6		
590	198396.052	2488601.92	3.421	1-Std. Building	6	6		
591	198440.278	2488846.778	3.21	1-Std. Building	6	6		
592	198431.326	2488848.617	3.21	1-Std. Building	6	6		

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SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
593	198434.674	2488821.556	3.21	1-Std. Building	6	6		
594	193328.15	2473651.897	1.123	Ditch		70		
595	191326.387	2469395.656	1.211	Ditch		70		
596	191318.038	2469383.351	1.21	Ditch		70		
597	191319.81	2469385.962	0.356	Ditch		70		
598	191324.596	2469393.016	0.389	Ditch		70		
599	191321.273	2469388.119	-1.685	Ditch		70		
600	191323.158	2469390.897	-1.765	Ditch		70		
601	193313.1	2473628.971	1.119	Ditch		70		
602	193315.703	2473632.937	0.265	Ditch		70		
603	193325.058	2473647.188	0.362	Ditch		70		
604	193318.7	2473637.502	-1.654	Ditch		70		
605	193321.16	2473641.25	-1.695	Ditch		70		
606	193350.36	2473685.732	1.148	Ditch		70		
607	193343.968	2473675.995	1.144	Ditch		70		
608	193345.13	2473677.766	0.325	Ditch		70		
609	193346.5	2473679.851	-1.321	Ditch		70		
610	190978.914	2468159.242	1.352	Ditch		70		
611	190981.898	2468174.346	1.285	Ditch		70		
612	190980.968	2468169.638	0.254	Ditch		70		
613	190979.518	2468162.3	0.365	Ditch		70		
614	193347.782	2473681.805	-1.321	Ditch		70		
615	193349.02	2473683.691	0.362	Ditch		70		
616	190976.025	2468144.624	1.214	Drain		30		
617	190976.361	2468146.322	1.265	Drain		30		
618	198420.396	2488883.136	2.7341	Garden	13.25	40		
619	198534.872	2488779.657	2.685	Garden	14.25	40		
620	198542.049	2488716.628	2.712	Garden	14.36	40		
621	197848.317	2487041.538	2.571	Garden	12.32	40		
622	197811.062	2487019.468	2.572	Garden	15.25	40		
623	197614.629	2486903.102	2.721	Garden	14.58	40		
624	197464.524	2486814.18	2.768	Garden	14.65	40		
625	197271.142	2486667.687	2.446	Garden	13.87	40		
626	197281.641	2486520.162	2.441	Garden	12.254	40		
627	197291.142	2486386.665	2.121	Garden	13.25	40		
628	197301.802	2486236.882	2.812	Garden	14.25	40		
629	197313.556	2486071.732	1.954	Garden	14.36	40		
630	197319.506	2485988.131	1.952	Garden	12.32	40		
631	197318.184	2485306.036	1.768	Garden	15.25	40		
632	197257.077	2484900.991	1.895	Garden	14.58	40		
633	197244.117	2484815.083	1.865	Garden	14.65	40		
634	197224.962	2484688.118	2.352	Garden	13.87	40		
635	197206.374	2484567.077	2.214	Garden	12.254	40		
636	196234.963	2483596.706	2.425	Garden	13.25	40		
637	194713.38	2482159.69	1.965	Garden	14.25	40		
638	194645.613	2482105.594	1.895	Garden	14.36	40		
639	194580.277	2482053.44	1.962	Garden	12.32	40		
640	194453.482	2481952.226	1.965	Garden	15.25	40		
641	194568.377	2480964.64	1.584	Garden	14.58	40		
642	194586.825	2480825.602	1.652	Garden	14.65	40		
643	194631.526	2480265.447	1.324	Garden	13.87	40		
644	194596.714	2480199.328	1.765	Garden	12.254	40		
645	194537.744	2480087.323	1.758	Garden	13.25	40		
646	194413.673	2479851.67	1.435	Garden	14.25	40		
647	194298.891	2479633.659	1.401	Garden	14.36	40		
648	194189.702	2479426.273	1.425	Garden	12.32	40		
649	194167.693	2479384.47	1.621	Garden	15.25	40		
650	194184.049	2478688.9	1.932	Garden	14.58	40		
651	194189.69	2478647.404	1.752	Garden	14.65	40		
652	194208.526	2478508.841	1.685	Garden	13.87	40		
653	194216.375	2478451.104	1.752	Garden	12.254	40		
654	194246.334	2478151.33	1.901	Garden	13.25	40		
655	194247.456	2478105.817	1.854	Garden	14.25	40		
656	194248.8	2478051.361	1.425	Garden	14.36	40		
657	194250.033	2478001.376	1.485	Garden	12.32	40		
658	194251.617	2477937.156	1.521	Garden	15.25	40		
659	194263.09	2477472.088	1.785	Garden	14.58	40		
660	194267.367	2477298.74	1.953	Garden	14.65	40		
661	194289.64	2476395.887	1.796	Garden	13.87	40		
662	194290.571	2476358.16	1.785	Garden	12.254	40		
663	194080.458	2476026.353	1.921	Garden	13.25	40		
664	193579.609	2475035.053	2.574	Garden	14.25	40		
665	193577.084	2474960.334	2.532	Garden	14.36	40		
666	193451.455	2473839.739	2.768	Garden	12.32	40		

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SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
667	192643.509	2471928.087	2.887	Garden	15.25	40		
668	191354.928	2469437.718	2.632	Garden	14.58	40		
669	190926.867	2467895.826	2.621	Garden	14.65	40		
670	190920.395	2467863.069	2.574	Garden	13.87	40		
671	190903.665	2467778.395	2.852	Garden	12.254	40		
672	190862.735	2467571.239	2.251	Garden	13.25	40		
673	189347.965	2464079.92	2.721	Garden	14.25	40		
674	189296.957	2463920.248	2.652	Garden	14.36	40		
675	189287.104	2463889.405	2.395	Garden	12.32	40		
676	189271.888	2463841.776	2.425	Garden	15.25	40		
677	189180.596	2463556.004	2.985	Garden	14.58	40		
678	189138.769	2463425.073	2.958	Garden	14.65	40		
679	190898.938	2467754.472	2.874	Garden	13.87	40		
680	189251.077	2463776.629	2.352	Garden	12.254	40		
681	190869.895	2467604.418	2.352	Garden	13.25	40		
682	194188.094	2478659.148	1.952	Garden	14.25	40		
683	194192.456	2478627.458	1.785	Garden	14.36	40		
684	194247.151	2478118.216	1.925	Garden	12.32	40		
685	191328.298	2469398.472	2.574	Garden	15.25	40		
686	192613.014	2471887.281	2.965	Garden	14.58	40		
687	194264.256	2477424.855	1.758	Garden	14.65	40		
688	194267.074	2477310.604	1.958	Garden	13.87	40		
689	192984.705	2472462.029	2.687	Garden	12.254	40		
690	193420.003	2473791.824	2.752	Garden	13.25	40		
691	194066.558	2476008.155	1.895	Garden	14.25	40		
692	194254.565	2479549.47	1.485	Garden	14.36	40		
693	194431.811	2479886.121	1.402	Garden	12.32	40		
694	196199.961	2483546.099	2.352	Garden	15.25	40		
695	194611.274	2480226.983	1.214	Garden	14.58	40		
696	197326.992	2485364.415	1.765	Garden	14.65	40		
697	197286.363	2486453.822	2.185	Garden	13.87	40		
698	197663.225	2486931.89	2.701	Garden	12.254	40		
699	197516.364	2486844.89	2.754	Garden	13.25	40		
700	198428.665	2488904.792	2.734	Garden	14.25	40		
701	188576.792	2462020.409	3.125	Garden	14.36	40		
702	188578.782	2462021.725	3.142	Garden	12.32	40		
703	189195.021	2463601.157	2.926	Garden	15.25	40		
704	189355.304	2464102.892	2.754	Garden	14.58	40		
705	190534.963	2466222.375	2.987	Garden	14.65	40		
706	190532.917	2466218.777	2.958	Garden	13.87	40		
707	190540.368	2466231.885	2.987	Garden	12.254	40		
708	190546.208	2466242.161	2.987	Garden	13.25	40		
709	192150.729	2470957.704	2.547	Garden	14.25	40		
710	192154.16	2470965.246	2.632	Garden	14.36	40		
711	192400.392	2471506.434	2.985	Garden	12.32	40		
712	192405.676	2471518.046	2.965	Garden	15.25	40		
713	192623.693	2471901.571	2.798	Garden	14.58	40		
714	192634.963	2471916.652	2.765	Garden	14.65	40		
715	192647.225	2471933.061	2.887	Garden	13.87	40		
716	192662.155	2471953.04	2.854	Garden	12.254	40		
717	192695.21	2471997.271	2.758	Garden	13.25	40		
718	192708.239	2472014.706	2.832	Garden	14.25	40		
719	192991.17	2472486.989	2.735	Garden	14.36	40		
720	193400.196	2473761.505	2.365	Garden	12.32	40		
721	193409.035	2473775.116	2.385	Garden	15.25	40		
722	193429.696	2473806.592	2.796	Garden	14.58	40		
723	193439.713	2473821.851	2.821	Garden	14.65	40		
724	194270.799	2477164.755	2.521	Garden	13.87	40		
725	194270.476	2477172.709	2.485	Garden	12.254	40		
726	194269.295	2477220.592	2.479	Garden	13.25	40		
727	194267.906	2477276.901	2.432	Garden	14.25	40		
728	194160.472	2479370.754	1.658	Garden	14.36	40		
729	194239.286	2479520.449	1.485	Garden	12.32	40		
730	194211.824	2479468.29	1.514	Garden	15.25	40		
731	194288.994	2479614.862	1.424	Garden	14.58	40		
732	194578.328	2480164.406	1.832	Garden	14.65	40		
733	194558.381	2480126.521	1.854	Garden	13.87	40		
734	196181.012	2483518.702	1.823	Garden	12.254	40		
735	196193.869	2483537.292	1.852	Garden	13.25	40		
736	196225.329	2483582.777	2.621	Garden	14.25	40		
737	196209.728	2483560.22	2.532	Garden	14.36	40		
738	197018.427	2484032.956	1.795	Garden	12.32	40		
739	197025.954	2484036.972	1.832	Garden	15.25	40		
740	197211.792	2484600.822	2.421	Garden	14.58	40		

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SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
741	197220.592	2484659.149	2.352	Garden	14.65	40		
742	197253.676	2484878.446	1.902	Garden	13.87	40		
743	197248.109	2484841.548	1.932	Garden	12.254	40		
744	197324.807	2485349.935	1.801	Garden	13.25	40		
745	197321.108	2485325.411	1.841	Garden	14.25	40		
746	197312.378	2486088.278	2.765	Garden	14.36	40		
747	197310.238	2486118.349	2.714	Garden	12.32	40		
748	197307.159	2486161.608	2.851	Garden	15.25	40		
749	197303.812	2486208.641	2.765	Garden	14.58	40		
750	197289.74	2486406.372	2.195	Garden	14.65	40		
751	197287.482	2486438.094	2.185	Garden	13.87	40		
752	197279.565	2486549.334	2.441	Garden	12.254	40		
753	197276.112	2486597.856	2.441	Garden	13.25	40		
754	197272.773	2486644.769	2.441	Garden	14.25	40		
755	197838.622	2487035.794	2.632	Garden	14.36	40		
756	197823.413	2487026.785	2.612	Garden	12.32	40		
757	198558.141	2488743.883	2.695	Garden	15.25	40		
758	198548.846	2488768.851	2.712	Garden	14.58	40		
759	193578.879	2475013.448	2.752	Garden	14.65	40		
760	193577.932	2474985.416	2.632	Garden	13.87	40		
761	194574.122	2480921.344	1.652	Garden	12.254	40		
762	194579.985	2480877.155	1.623	Garden	13.25	40		
763	194546.443	2482026.432	2.021	Garden	14.25	40		
764	194498.214	2481987.933	1.996	Garden	14.36	40		
765	194689.364	2482140.518	1.965	Garden	12.32	40		
766	194668.153	2482123.587	1.989	Garden	15.25	40		
767	197315.192	2486048.735	1.995	Garden	14.58	40		
768	197317.572	2486015.307	2.012	Garden	14.65	40		
769	197481.929	2486824.491	2.757	Garden	13.87	40		
770	197498.143	2486834.096	2.852	Garden	12.254	40		
771	198519.423	2488791.603	2.72	Homestead		6		
772	198403.33	2488666.113	2.721	Homestead		6		
773	198312.166	2488461.934	2.621	Homestead		6		
774	193572.682	2474830.066	2.754	Homestead		6		
775	191285.955	2469336.069	2.958	Homestead		6		
776	191289.193	2469340.839	2.965	Homestead		6		
777	193572.425	2474822.455	2.795	Homestead		6		
778	197539.366	2486858.517	2.835	Homestead		6		
779	197558.718	2486869.98	2.832	Homestead		6		
780	198384.66	2488641.94	2.752	Homestead		6		
781	198414.985	2488670.357	2.762	Homestead		6		
782	198534.055	2488780.289	2.721	Homestead		6		
783	197329.048	2485378.041	3.419	Earthen Road		65		
784	196197.473	2483542.503	3.412	Earthen Road		65		
785	195969.741	2483213.565	3.22	Earthen Road		65		
786	195901.844	2483115.08	3.21	Earthen Road		65		
787	195887.259	2483093.992	3.312	Earthen Road		65		
788	194260.356	2479560.469	3.144	Earthen Road		65		
789	192982.776	2472455.323	3.144	Earthen Road		65		
790	192397.694	2471500.504	3.174	Earthen Road		65		
791	192609.57	2471882.673	3.121	Earthen Road		65		
792	192611.574	2471885.354	3.125	Earthen Road		65		
793	194266.828	2477320.604	2.11	Earthen Road		65		
794	194267.055	2477311.395	2.112	Earthen Road		65		
795	192984.155	2472459.287	3.142	Earthen Road		65		
796	193361.76	2473703.099	3.254	Earthen Road		65		
797	193364.148	2473706.736	3.255	Earthen Road		65		
798	194265.552	2479570.338	3.142	Earthen Road		65		
799	194434.08	2479890.43	3.412	Earthen Road		65		
800	194435.576	2479893.272	3.409	Earthen Road		65		
801	196194.921	2483538.813	3.41	Earthen Road		65		
802	195967.721	2483210.645	3.221	Earthen Road		65		
803	197330.123	2485383.069	3.421	Earthen Road		65		
804	197312.873	2486081.329	3.431	Earthen Road		65		
805	197312.618	2486084.915	3.432	Earthen Road		65		
806	198127.907	2487207.166	3.519	Earthen Road		65		
807	198133.159	2487210.277	3.512	Earthen Road		65		
808	198058.419	2487166.001	3.42	Earthen Road		65		
809	198050.976	2487161.593	3.422	Earthen Road		65		
810	192399.478	2471504.425	3.195	Earthen Road		65		
811	197286.158	2486456.697	1.411	Canal		75		
812	196178.617	2483515.24	1.365	Canal		75		
813	196175.473	2483510.695	0.854	Canal		75		
814	196102.54	2483405.247	-2.352	Canal		75		

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815	196077.824	2483369.512	-4.521	Canal		75		
816	196037.781	2483311.618	0.584	Canal		75		
817	195997.539	2483253.436	-4.595	Canal		75		
818	194450.356	2481854.153	1.11	Canal		75		
819	194497.248	2481500.736	0.941	Canal		75		
820	194609.348	2480223.325	0.821	Canal		75		
821	194187.309	2479421.727	0.802	Canal		75		
822	194169.455	2478796.261	0.612	Canal		75		
823	194256.832	2476257.27	0.395	Canal		75		
824	194137.86	2476101.506	0.309	Canal		75		
825	193373.425	2473720.868	1.289	Canal		75		
826	190556.333	2466259.975	-3.652	Canal		75		
827	190919.541	2467858.374	1.214	Canal		75		
828	190917.563	2467848.735	1.254	Canal		75		
829	190917.878	2467850.331	0.124	Canal		75		
830	190918.929	2467855.649	0.158	Canal		75		
831	190918.174	2467851.827	-1.354	Canal		75		
832	190869.432	2467605.136	1.365	Canal		75		
833	190871.286	2467614.516	1.262	Canal		75		
834	190870.962	2467612.877	0.726	Canal		75		
835	190869.937	2467607.693	0.685	Canal		75		
836	190870.648	2467611.291	-2.432	Canal		75		
837	190710.991	2466803.236	1.254	Canal		75		
838	190712.339	2466810.057	1.21	Canal		75		
839	190712.097	2466808.833	0.341	Canal		75		
840	190711.3	2466804.799	0.241	Canal		75		
841	190711.584	2466806.235	-2.321	Canal		75		
842	190711.835	2466807.509	-2.364	Canal		75		
843	190547.129	2466243.78	1.235	Canal		75		
844	190572.416	2466288.271	1.268	Canal		75		
845	190567.969	2466280.445	0.174	Canal		75		
846	190550.578	2466249.848	0.125	Canal		75		
847	190562.463	2466270.759	-3.695	Canal		75		
848	189755.578	2464851.148	1.241	Canal		75		
849	189760.082	2464859.072	1.124	Canal		75		
850	189759.368	2464857.815	0.125	Canal		75		
851	189756.409	2464852.61	0.125	Canal		75		
852	189757.592	2464854.692	-2.354	Canal		75		
853	189758.434	2464856.173	-2.384	Canal		75		
854	189196.148	2463604.686	1.574	Canal		75		
855	189197.706	2463609.562	1.596	Canal		75		
856	189196.521	2463605.853	0.251	Canal		75		
857	189197.391	2463608.578	0.352	Canal		75		
858	189196.779	2463606.661	-2.352	Canal		75		
859	188986.396	2462948.097	1.011	Canal		75		
860	188988.744	2462955.448	1.056	Canal		75		
861	188988.199	2462953.74	-1.321	Canal		75		
862	188986.783	2462949.308	-1.253	Canal		75		
863	188987.638	2462951.984	-3.265	Canal		75		
864	188987.308	2462950.736	-3.254	Canal		75		
865	189197.1	2463607.397	-2.362	Canal		75		
866	190918.549	2467853.726	-1.411	Canal		75		
867	190870.349	2467609.775	-2.365	Canal		75		
868	194141.183	2479004.239	0.81	Canal		75		
869	194140.176	2479011.642	0.85	Canal		75		
870	194140.355	2479010.33	-1.13	Canal		75		
871	194140.931	2479006.09	-1.11	Canal		75		
872	194140.743	2479007.472	-2.365	Canal		75		
873	194140.548	2479008.904	-2.395	Canal		75		
874	194170.591	2478787.904	0.621	Canal		75		
875	194169.668	2478794.689	-1.13	Canal		75		
876	194170.334	2478789.792	-1.15	Canal		75		
877	194169.866	2478793.238	-2.625	Canal		75		
878	194170.137	2478791.239	-2.584	Canal		75		
879	191359.791	2469444.884	1.174	Canal		75		
880	191362.514	2469448.899	1.265	Canal		75		
881	191360.475	2469445.893	0.584	Canal		75		
882	191361.843	2469447.909	0.632	Canal		75		
883	191360.877	2469446.485	-1.587	Canal		75		
884	191361.288	2469447.092	-1.632	Canal		75		
885	194267.772	2477282.326	0.395	Canal		75		
886	194267.714	2477284.682	-1.562	Canal		75		
887	194267.394	2477297.63	0.423	Canal		75		
888	194267.473	2477294.448	-1.42	Canal		75		

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SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
889	194267.624	2477288.339	-3.125	Canal		75		
890	194267.552	2477291.25	-3.025	Canal		75		
891	194288.483	2476442.805	0.425	Canal		75		
892	194288.654	2476435.89	0.374	Canal		75		
893	194288.613	2476437.542	-1.325	Canal		75		
894	194288.51	2476441.699	-1.394	Canal		75		
895	194288.571	2476439.219	-2.654	Canal		75		
896	194288.541	2476440.47	-2.695	Canal		75		
897	193398.812	2473759.485	1.354	Canal		75		
898	193393.801	2473751.91	-1.362	Canal		75		
899	193378.377	2473728.355	-1.214	Canal		75		
900	193383.806	2473736.626	-3.251	Canal		75		
901	193388.255	2473743.403	-3.621	Canal		75		
902	194144.965	2476110.808	0.31	Canal		75		
903	194139.482	2476103.63	-1.121	Canal		75		
904	194143.987	2476109.528	-1.219	Canal		75		
905	194141.226	2476105.913	-2.365	Canal		75		
906	194142.487	2476107.564	-2.365	Canal		75		
907	194058.705	2475997.873	0.532	Canal		75		
908	194064.82	2476005.879	0.584	Canal		75		
909	194063.455	2476004.091	-1.265	Canal		75		
910	194059.746	2475999.235	-1.232	Canal		75		
911	194060.989	2476000.864	-3.254	Canal		75		
912	194062.184	2476002.428	-3.265	Canal		75		
913	193702.598	2475531.643	-1.122	Canal		75		
914	193705.768	2475535.792	0.412	Canal		75		
915	193698.52	2475526.304	0.445	Canal		75		
916	193699.89	2475528.097	-0.32	Canal		75		
917	193704.186	2475533.721	-0.322	Canal		75		
918	193701.115	2475529.7	-1.119	Canal		75		
919	193560.58	2474471.954	0.574	Canal		75		
920	193559.95	2474453.3	0.511	Canal		75		
921	193560.037	2474455.889	-1.612	Canal		75		
922	193560.414	2474467.025	-1.232	Canal		75		
923	193560.169	2474459.793	-2.352	Canal		75		
924	193560.288	2474463.306	-2.396	Canal		75		
925	194169.514	2479387.928	0.811	Canal		75		
926	194173.085	2479394.712	-1.325	Canal		75		
927	194182.938	2479413.426	-1.321	Canal		75		
928	194179.656	2479407.191	-2.695	Canal		75		
929	194176.131	2479400.496	-2.865	Canal		75		
930	194600.275	2480206.091	0.836	Canal		75		
931	194601.894	2480209.167	-1.51	Canal		75		
932	194607.798	2480220.38	-1.548	Canal		75		
933	194603.812	2480212.809	-3.124	Canal		75		
934	194605.765	2480216.519	-3.024	Canal		75		
935	194534.702	2481218.448	0.896	Canal		75		
936	194533.438	2481227.978	0.911	Canal		75		
937	194534.446	2481220.38	-1.251	Canal		75		
938	194533.598	2481226.767	-1.222	Canal		75		
939	194534.19	2481222.308	-2.952	Canal		75		
940	194533.872	2481224.707	-2.965	Canal		75		
941	194841.545	2482261.997	1.125	Canal		75		
942	194847.444	2482266.706	1.126	Canal		75		
943	194842.561	2482262.808	-0.248	Canal		75		
944	194846.366	2482265.845	-0.254	Canal		75		
945	194843.795	2482263.793	-1.328	Canal		75		
946	194845.028	2482264.777	-1.321	Canal		75		
947	194449.052	2481863.983	1.115	Canal		75		
948	194449.318	2481861.978	-0.231	Canal		75		
949	194450.121	2481855.927	-0.23	Canal		75		
950	194449.573	2481860.056	-2.721	Canal		75		
951	194449.881	2481857.732	-2.652	Canal		75		
952	194495.665	2481512.669	0.956	Canal		75		
953	194495.939	2481510.599	-1.254	Canal		75		
954	194496.933	2481503.108	-1.523	Canal		75		
955	194496.621	2481505.462	-2.754	Canal		75		
956	194496.299	2481507.887	-2.765	Canal		75		
957	197329.93	2485383.889	1.411	Canal		75		
958	197330.312	2485386.423	1.332	Canal		75		
959	197330.015	2485384.455	-1.345	Canal		75		
960	197330.231	2485385.882	-1.342	Canal		75		
961	197330.104	2485385.045	-2.652	Canal		75		
962	197330.154	2485385.378	-2.721	Canal		75		

Bhandaria-Mathbaria132kV Double Circuit Line								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
963	197282.428	2486509.104	1.418	Canal		75		
964	197283.154	2486498.913	-1.625	Canal		75		
965	197285.533	2486465.483	-1.325	Canal		75		
966	197284.615	2486478.377	-3.254	Canal		75		
967	197283.827	2486489.448	-3.296	Canal		75		
968	198047.46	2487159.509	1.602	Canal		75		
969	197898.745	2487071.411	1.615	Canal		75		
970	197900.597	2487072.508	-1.365	Canal		75		
971	197907.678	2487076.703	1.595	Canal		75		
972	197905.929	2487075.667	-1.421	Canal		75		
973	197902.621	2487073.707	-2.698	Canal		75		
974	197904.291	2487074.696	-2.758	Canal		75		
975	197872.976	2487056.146	1.602	Canal		75		
976	197852.597	2487044.073	1.659	Canal		75		
977	197856.385	2487046.317	-1.325	Canal		75		
978	197869.294	2487053.965	-1.395	Canal		75		
979	197861.256	2487049.203	-2.921	Canal		75		
980	197865.784	2487051.885	-2.985	Canal		75		
981	198429.402	2487557.083	1.625	Canal		75		
982	198434.335	2487574.99	1.621	Canal		75		
983	198430.426	2487560.801	0.254	Canal		75		
984	198433.34	2487571.379	0.352	Canal		75		
985	198431.549	2487564.879	-2.365	Canal		75		
986	198432.505	2487568.347	-2.695	Canal		75		
987	192710.202	2472017.333	1.217	Canal		75		
988	192713.703	2472022.018	1.217	Canal		75		
989	192710.962	2472018.349	0.251	Canal		75		
990	192711.633	2472019.247	-1.325	Canal		75		
991	192712.262	2472020.09	-1.395	Canal		75		
992	192712.941	2472020.998	0.251	Canal		75		
993	193758.39	2475604.688	-1.122	Canal		75		
994	193759.97	2475606.66	0.412	Canal		75		
995	193756.563	2475602.296	0.445	Canal		75		
996	193757.027	2475602.904	-0.32	Canal		75		
997	193759.126	2475605.651	-0.322	Canal		75		
998	193757.639	2475603.704	-1.119	Canal		75		
999	194250.72	2476249.267	0.421	Canal		75		
1000	194252.355	2476251.408	-1.365	Canal		75		
1001	194253.559	2476252.984	-2.854	Canal		75		
1002	194254.661	2476254.427	-2.695	Canal		75		
1003	194255.774	2476255.884	-1.395	Canal		75		
1004	195972.26	2483216.888	1.425	Canal		75		
1005	196007.761	2483268.215	-4.965	Canal		75		
1006	195988.796	2483240.796	-2.325	Canal		75		
1007	195976.793	2483223.442	0.352	Canal		75		
1008	196017.345	2483282.072	-1.365	Canal		75		
1009	196050.852	2483330.516	-1.685	Canal		75		
1010	196063.906	2483349.39	-2.365	Canal		75		
1011	196090.882	2483388.392	-4.621	Canal		75		
1012	196115.09	2483424.03	1.652	Canal		75		
1013	196157.854	2483485.22	-4.851	Canal		75		
1014	196149.047	2483472.488	-3.254	Canal		75		
1015	196136.975	2483455.034	-1.324	Canal		75		
1016	196124.202	2483436.566	0.954	Canal		75		
1017	196164.378	2483494.653	-4.721	Canal		75		
1018	196170.854	2483504.017	-2.251	Canal		75		
1019	197226.977	2484701.475	1.321	Canal		75		
1020	197225.7	2484693.008	1.365	Canal		75		
1021	197226.724	2484699.8	0.152	Canal		75		
1022	197226.444	2484697.939	-2.395	Canal		75		
1023	197226.194	2484696.282	-2.365	Canal		75		
1024	197225.922	2484694.48	0.121	Canal		75		
1025	198042.242	2487156.419	1.632	Canal		75		
1026	198043.191	2487156.98	0.365	Canal		75		
1027	198044.085	2487157.51	-2.251	Canal		75		
1028	198045.201	2487158.171	-2.321	Canal		75		
1029	198046.239	2487158.786	0.412	Canal		75		
1030	197597.828	2486893.149	3.514	Paved Road		60		
1031	197531.569	2486853.897	3.521	Paved Road		60		
1032	197518.518	2486846.166	3.515	Paved Road		60		
1033	196026.888	2483295.869	2.912	Paved Road		60		
1034	193584.903	2475191.712	3.329	Paved Road		60		
1035	193571.562	2474796.934	2.961	Paved Road		60		
1036	193561.256	2474491.934	2.632	Paved Road		60		

Bhandaria-Mathbaria132kV Double Circuit Line								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1037	193411.903	2473779.576	3.211	Paved Road		60		
1038	192224.087	2471118.937	3.14	Paved Road		60		
1039	190977.908	2468154.152	3.242	Paved Road		60		
1040	188570.847	2462016.476	3.265	Paved Road		60		
1041	188574.362	2462018.801	3.266	Paved Road		60		
1042	190976.777	2468148.428	3.241	Paved Road		60		
1043	190573.875	2466290.836	3.24	Paved Road		60		
1044	190575.694	2466294.037	3.241	Paved Road		60		
1045	190536.877	2466225.743	3.147	Paved Road		60		
1046	190538.762	2466229.06	3.146	Paved Road		60		
1047	190034.574	2465342.005	3.312	Paved Road		60		
1048	190036.868	2465346.041	3.311	Paved Road		60		
1049	188985.803	2462946.242	3.412	Paved Road		60		
1050	188983.997	2462940.587	3.411	Paved Road		60		
1051	189136.864	2463419.109	3.241	Paved Road		60		
1052	189137.981	2463422.605	3.242	Paved Road		60		
1053	189356.556	2464106.812	3.211	Paved Road		60		
1054	189357.628	2464110.167	3.213	Paved Road		60		
1055	194188.581	2478655.559	2.732	Paved Road		60		
1056	194189.512	2478648.713	2.754	Paved Road		60		
1057	194247.231	2478114.96	2.621	Paved Road		60		
1058	194247.398	2478108.184	2.654	Paved Road		60		
1059	191282.622	2469331.155	3.121	Paved Road		60		
1060	191285.219	2469334.984	3.12	Paved Road		60		
1061	191363.536	2469450.404	3.14	Paved Road		60		
1062	191364.913	2469452.434	3.141	Paved Road		60		
1063	192231.369	2471134.942	3.141	Paved Road		60		
1064	193416.017	2473785.003	3.212	Paved Road		60		
1065	193584.719	2475186.26	3.33	Paved Road		60		
1066	193571.203	2474786.292	2.985	Paved Road		60		
1067	193560.814	2474478.869	2.598	Paved Road		60		
1068	197010.567	2484028.763	3.312	Paved Road		60		
1069	197015.319	2484031.298	3.311	Paved Road		60		
1070	196031.086	2483301.938	2.932	Paved Road		60		
1071	195472.805	2482746.555	3.31	Paved Road		60		
1072	195476.06	2482748.905	3.312	Paved Road		60		
1073	197229.38	2484717.404	3.122	Paved Road		60		
1074	197227.761	2484706.669	3.121	Paved Road		60		
1075	197577.664	2486881.204	3.515	Paved Road		60		
1076	198363.619	2488589.694	3.621	Paved Road		60		
1077	198366.341	2488596.453	3.62	Paved Road		60		
1078	194270.831	2477158.334	2.365	RCC Road		60		
1079	194270.626	2477161.968	2.395	RCC Road		60		
1080	194236.298	2478080.919	2.612	Semipucca	5	6		
1081	194228.361	2478081.133	2.612	Semipucca	5	6		
1082	194233.509	2478059.277	2.612	Semipucca	5	6		
1083	194255.767	2478074.746	2.612	Semipucca	5	6		
1084	194263.446	2478074.321	2.612	Semipucca	5	6		
1085	194254.556	2478062.282	2.612	Semipucca	5	6		
1086	194189.792	2478662.204	2.658	Semipucca	5	6		
1087	194189.344	2478669.415	2.658	Semipucca	5	6		
1088	194199.462	2478661.364	2.658	Semipucca	5	6		
1089	198419.651	2488902.563	2.865	Semipucca	5	6		
1090	198410.156	2488905.334	2.865	Semipucca	5	6		
1091	198416.841	2488892.768	2.865	Semipucca	5	6		
1092	190902.283	2467764.27	2.992	Tinshed	5	6		
1093	190890.756	2467768.802	2.992	Tinshed	5	6		
1094	190900.235	2467757.942	2.992	Tinshed	5	6		
1095	192610.318	2471899.515	3.052	Tinshed	5	6		
1096	192612.745	2471914.005	3.052	Tinshed	5	6		
1097	192602.271	2471900.924	3.052	Tinshed	5	6		
1098	194177.34	2478680.259	2.658	Tinshed	5	6		
1099	194183.714	2478678.824	2.658	Tinshed	5	6		
1100	194182.805	2478674.804	2.658	Tinshed	5	6		
1101	194590.883	2480833.892	1.952	Tinshed	5	6		
1102	194591.804	2480842.778	1.952	Tinshed	5	6		
1103	194585.742	2480842.997	1.952	Tinshed	5	6		
1104	194685.34	2482149.361	2.032	Tinshed	5	6		
1105	194686.162	2482160.466	2.032	Tinshed	5	6		
1106	194681.208	2482160.94	2.032	Tinshed	5	6		
1107	197263.406	2486626.849	2.758	Tinshed	5	6		
1108	197253.478	2486628.685	2.758	Tinshed	5	6		
1109	197250.796	2486613.676	2.758	Tinshed	5	6		
1110	197625.684	2486912.043	3.021	Tinshed	5	6		

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SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1111	197633.408	2486912.446	3.021	Tinshed	5	6		
1112	197632.053	2486909.359	3.021	Tinshed	5	6		
1113	197638.451	2486918.5	3.021	Tinshed	5	6		
1114	197648.142	2486915.365	3.021	Tinshed	5	6		
1115	197634.47	2486905.069	3.021	Tinshed	5	6		
1116	197624.859	2486917.692	3.021	Tinshed	5	6		
1117	197631.174	2486915.253	3.021	Tinshed	5	6		
1118	197635.35	2486926.902	3.021	Tinshed	5	6		
1119	198324.68	2488473.955	3.021	Tinshed	5	6		
1120	198327.196	2488482.319	3.021	Tinshed	5	6		
1121	198331.785	2488480.684	3.021	Tinshed	5	6		
1122	198347.611	2488579.494	3.214	Tinshed	5	6		
1123	198354.272	2488578.865	3.214	Tinshed	5	6		
1124	198353.499	2488561.802	3.214	Tinshed	5	6		
1125	198420.396	2488883.136	2.7341	Tree	13.25			
1126	198534.872	2488779.657	2.685	Tree	14.25			
1127	198542.049	2488716.628	2.712	Tree	14.36			
1128	197848.317	2487041.538	2.571	Tree	12.32			
1129	197811.062	2487019.468	2.572	Tree	15.25			
1130	197614.629	2486903.102	2.721	Tree	14.58			
1131	197464.524	2486814.18	2.768	Tree	14.65			
1132	197271.142	2486667.687	2.446	Tree	13.87			
1133	197281.641	2486520.162	2.441	Tree	12.254			
1134	197291.142	2486386.665	2.121	Tree	13.25			
1135	197301.802	2486236.882	2.812	Tree	14.25			
1136	197313.556	2486071.732	1.954	Tree	14.36			
1137	197319.506	2485988.131	1.952	Tree	12.32			
1138	197318.184	2485306.036	1.768	Tree	15.25			
1139	197257.077	2484900.991	1.895	Tree	14.58			
1140	197244.117	2484815.083	1.865	Tree	14.65			
1141	197224.962	2484688.118	2.352	Tree	13.87			
1142	197206.374	2484567.077	2.214	Tree	12.254			
1143	196234.963	2483596.706	2.425	Tree	13.25			
1144	194713.38	2482159.69	1.965	Tree	14.25			
1145	194645.613	2482105.594	1.895	Tree	14.36			
1146	194580.277	2482053.44	1.962	Tree	12.32			
1147	194453.482	2481952.226	1.965	Tree	15.25			
1148	194568.377	2480964.64	1.584	Tree	14.58			
1149	194586.825	2480825.602	1.652	Tree	14.65			
1150	194631.526	2480265.447	1.324	Tree	13.87			
1151	194596.714	2480199.328	1.765	Tree	12.254			
1152	194537.744	2480087.323	1.758	Tree	13.25			
1153	194413.673	2479851.67	1.435	Tree	14.25			
1154	194298.891	2479633.659	1.401	Tree	14.36			
1155	194189.702	2479426.273	1.425	Tree	12.32			
1156	194167.693	2479384.47	1.621	Tree	15.25			
1157	194184.049	2478688.9	1.932	Tree	14.58			
1158	194189.69	2478647.404	1.752	Tree	14.65			
1159	194208.526	2478508.841	1.685	Tree	13.87			
1160	194216.375	2478451.104	1.752	Tree	12.254			
1161	194246.334	2478151.33	1.901	Tree	13.25			
1162	194247.456	2478105.817	1.854	Tree	14.25			
1163	194248.8	2478051.361	1.425	Tree	14.36			
1164	194250.033	2478001.376	1.485	Tree	12.32			
1165	194251.617	2477937.156	1.521	Tree	15.25			
1166	194263.09	2477472.088	1.785	Tree	14.58			
1167	194267.367	2477298.74	1.953	Tree	14.65			
1168	194289.64	2476395.887	1.796	Tree	13.87			
1169	194290.571	2476358.16	1.785	Tree	12.254			
1170	194080.458	2476026.353	1.921	Tree	13.25			
1171	193579.609	2475035.053	2.574	Tree	14.25			
1172	193577.084	2474960.334	2.532	Tree	14.36			
1173	193451.455	2473839.739	2.768	Tree	12.32			
1174	192643.509	2471928.087	2.887	Tree	15.25			
1175	191354.928	2469437.718	2.632	Tree	14.58			
1176	190926.867	2467895.826	2.621	Tree	14.65			
1177	190920.395	2467863.069	2.574	Tree	13.87			
1178	190903.665	2467778.395	2.852	Tree	12.254			
1179	190862.735	2467571.239	2.251	Tree	13.25			
1180	189347.965	2464079.92	2.721	Tree	14.25			
1181	189296.957	2463920.248	2.652	Tree	14.36			
1182	189287.104	2463889.405	2.395	Tree	12.32			
1183	189271.888	2463841.776	2.425	Tree	15.25			
1184	189180.596	2463556.004	2.985	Tree	14.58			

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SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1185	189138.769	2463425.073	2.958	Tree	14.65			
1186	190898.938	2467754.472	2.874	Tree	13.87			
1187	189251.077	2463776.629	2.352	Tree	12.254			
1188	190869.895	2467604.418	2.352	Tree	13.25			
1189	194188.094	2478659.148	1.952	Tree	14.25			
1190	194192.456	2478627.458	1.785	Tree	14.36			
1191	194247.151	2478118.216	1.925	Tree	12.32			
1192	191328.298	2469398.472	2.574	Tree	15.25			
1193	192613.014	2471887.281	2.965	Tree	14.58			
1194	194264.256	2477424.855	1.758	Tree	14.65			
1195	194267.074	2477310.604	1.958	Tree	13.87			
1196	192984.705	2472462.029	2.687	Tree	12.254			
1197	193420.003	2473791.824	2.752	Tree	13.25			
1198	194066.558	2476008.155	1.895	Tree	14.25			
1199	194254.565	2479549.47	1.485	Tree	14.36			
1200	194431.811	2479886.121	1.402	Tree	12.32			
1201	196199.961	2483546.099	2.352	Tree	15.25			
1202	194611.274	2480226.983	1.214	Tree	14.58			
1203	197326.992	2485364.415	1.765	Tree	14.65			
1204	197286.363	2486453.822	2.185	Tree	13.87			
1205	197663.225	2486931.89	2.701	Tree	12.254			
1206	197516.364	2486844.89	2.754	Tree	13.25			
1207	198428.665	2488904.792	2.734	Tree	14.25			
1208	188576.792	2462020.409	3.125	Tree	14.36			
1209	188578.782	2462021.725	3.142	Tree	12.32			
1210	189195.021	2463601.157	2.926	Tree	15.25			
1211	189355.304	2464102.892	2.754	Tree	14.58			
1212	190534.963	2466222.375	2.987	Tree	14.65			
1213	190532.917	2466218.777	2.958	Tree	13.87			
1214	190540.368	2466231.885	2.987	Tree	12.254			
1215	190546.208	2466242.161	2.987	Tree	13.25			
1216	192150.729	2470957.704	2.547	Tree	14.25			
1217	192154.16	2470965.246	2.632	Tree	14.36			
1218	192400.392	2471506.434	2.985	Tree	12.32			
1219	192405.676	2471518.046	2.965	Tree	15.25			
1220	192623.693	2471901.571	2.798	Tree	14.58			
1221	192634.963	2471916.652	2.765	Tree	14.65			
1222	192647.225	2471933.061	2.887	Tree	13.87			
1223	192662.155	2471953.04	2.854	Tree	12.254			
1224	192695.21	2471997.271	2.758	Tree	13.25			
1225	192708.239	2472014.706	2.832	Tree	14.25			
1226	192991.17	2472486.989	2.735	Tree	14.36			
1227	193400.196	2473761.505	2.365	Tree	12.32			
1228	193409.035	2473775.116	2.385	Tree	15.25			
1229	193429.696	2473806.592	2.796	Tree	14.58			
1230	193439.713	2473821.851	2.821	Tree	14.65			
1231	194270.799	2477164.755	2.521	Tree	13.87			
1232	194270.476	2477172.709	2.485	Tree	12.254			
1233	194269.295	2477220.592	2.479	Tree	13.25			
1234	194267.906	2477276.901	2.432	Tree	14.25			
1235	194160.472	2479370.754	1.658	Tree	14.36			
1236	194239.286	2479520.449	1.485	Tree	12.32			
1237	194211.824	2479468.29	1.514	Tree	15.25			
1238	194288.994	2479614.862	1.424	Tree	14.58			
1239	194578.328	2480164.406	1.832	Tree	14.65			
1240	194558.381	2480126.521	1.854	Tree	13.87			
1241	196181.012	2483518.702	1.823	Tree	12.254			
1242	196193.869	2483537.292	1.852	Tree	13.25			
1243	196225.329	2483582.777	2.621	Tree	14.25			
1244	196209.728	2483560.22	2.532	Tree	14.36			
1245	197018.427	2484032.956	1.795	Tree	12.32			
1246	197025.954	2484036.972	1.832	Tree	15.25			
1247	197211.792	2484600.822	2.421	Tree	14.58			
1248	197220.592	2484659.149	2.352	Tree	14.65			
1249	197253.676	2484878.446	1.902	Tree	13.87			
1250	197248.109	2484841.548	1.932	Tree	12.254			
1251	197324.807	2485349.935	1.801	Tree	13.25			
1252	197321.108	2485325.411	1.841	Tree	14.25			
1253	197312.378	2486088.278	2.765	Tree	14.36			
1254	197310.238	2486118.349	2.714	Tree	12.32			
1255	197307.159	2486161.608	2.851	Tree	15.25			
1256	197303.812	2486208.641	2.765	Tree	14.58			
1257	197289.74	2486406.372	2.195	Tree	14.65			
1258	197287.482	2486438.094	2.185	Tree	13.87			

Bhandaria-Mathbaria132kV Double Circuit Line								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1259	197279.565	2486549.334	2.441	Tree	12.254			
1260	197276.112	2486597.856	2.441	Tree	13.25			
1261	197272.773	2486644.769	2.441	Tree	14.25			
1262	197838.622	2487035.794	2.632	Tree	14.36			
1263	197823.413	2487026.785	2.612	Tree	12.32			
1264	198558.141	2488743.883	2.695	Tree	15.25			
1265	198548.846	2488768.851	2.712	Tree	14.58			
1266	193578.879	2475013.448	2.752	Tree	14.65			
1267	193577.932	2474985.416	2.632	Tree	13.87			
1268	194574.122	2480921.344	1.652	Tree	12.254			
1269	194579.985	2480877.155	1.623	Tree	13.25			
1270	194546.443	2482026.432	2.021	Tree	14.25			
1271	194498.214	2481987.933	1.996	Tree	14.36			
1272	194689.364	2482140.518	1.965	Tree	12.32			
1273	194668.153	2482123.587	1.989	Tree	15.25			
1274	197315.192	2486048.735	1.995	Tree	14.58			
1275	197317.572	2486015.307	2.012	Tree	14.65			
1276	197481.929	2486824.491	2.757	Tree	13.87			
1277	197498.143	2486834.096	2.852	Tree	12.254			
1278	198519.423	2488791.603	2.72	Tree	13.25			
1279	198403.33	2488666.113	2.721	Tree	14.25			
1280	198312.166	2488461.934	2.621	Tree	14.36			
1281	193572.682	2474830.066	2.754	Tree	12.32			
1282	191285.955	2469336.069	2.958	Tree	15.25			
1283	191289.193	2469340.839	2.965	Tree	14.58			
1284	193572.425	2474822.455	2.795	Tree	14.65			
1285	197539.366	2486858.517	2.835	Tree	13.87			
1286	197558.718	2486869.98	2.832	Tree	12.254			
1287	198384.66	2488641.94	2.752	Tree	13.25			
1288	198414.985	2488670.357	2.762	Tree	14.25			
1289	198534.055	2488780.289	2.721	Tree	14.36			
1290	197329.048	2485378.041	3.419	Tree	12.32			
1291	196197.473	2483542.503	3.412	Tree	15.25			
1292	195969.741	2483213.565	3.22	Tree	14.58			
1293	195901.844	2483115.08	3.21	Tree	14.65			
1294	195887.259	2483093.992	3.312	Tree	13.87			
1295	194260.356	2479560.469	3.144	Tree	12.254			
1296	192982.776	2472455.323	3.144	Tree	13.25			
1297	192397.694	2471500.504	3.174	Tree	14.25			
1298	192609.57	2471882.673	3.121	Tree	14.36			
1299	192611.574	2471885.354	3.125	Tree	12.32			
1300	194266.828	2477320.604	2.11	Tree	15.25			
1301	194267.055	2477311.395	2.112	Tree	14.58			
1302	192984.155	2472459.287	3.142	Tree	14.65			
1303	193361.76	2473703.099	3.254	Tree	13.87			
1304	193364.148	2473706.736	3.255	Tree	12.254			
1305	194265.552	2479570.338	3.142	Tree	13.25			
1306	194434.08	2479890.43	3.412	Tree	14.25			
1307	194435.576	2479893.272	3.409	Tree	14.36			
1308	196194.921	2483538.813	3.41	Tree	12.32			
1309	195967.721	2483210.645	3.221	Tree	15.25			
1310	197330.123	2485383.069	3.421	Tree	14.58			
1311	197312.873	2486081.329	3.431	Tree	14.65			
1312	197312.618	2486084.915	3.432	Tree	13.87			
1313	198127.907	2487207.166	3.519	Tree	12.254			
1314	198133.159	2487210.277	3.512	Tree	13.25			
1315	198058.419	2487166.001	3.42	Tree	14.25			
1316	198050.976	2487161.593	3.422	Tree	14.36			
1317	192399.478	2471504.425	3.195	Tree	12.32			
1318	197597.828	2486893.149	3.514	Tree	15.25			
1319	197531.569	2486853.897	3.521	Tree	14.58			
1320	197518.518	2486846.166	3.515	Tree	14.65			
1321	196026.888	2483295.869	2.912	Tree	13.87			
1322	193584.903	2475191.712	3.329	Tree	12.254			
1323	193571.562	2474796.934	2.961	Tree	13.25			
1324	193561.256	2474491.934	2.632	Tree	14.25			
1325	193411.903	2473779.576	3.211	Tree	14.36			
1326	192224.087	2471118.937	3.14	Tree	12.32			
1327	190977.908	2468154.152	3.242	Tree	15.25			
1328	188570.847	2462016.476	3.265	Tree	14.58			
1329	188574.362	2462018.801	3.266	Tree	14.65			
1330	190976.777	2468148.428	3.241	Tree	13.87			
1331	190573.875	2466290.836	3.24	Tree	12.254			
1332	190575.694	2466294.037	3.241	Tree	13.25			

Bhandaria-Mathbaria132kV Double Circuit Line								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1333	190536.877	2466225.743	3.147	Tree	14.25			
1334	190538.762	2466229.06	3.146	Tree	14.36			
1335	190034.574	2465342.005	3.312	Tree	12.32			
1336	190036.868	2465346.041	3.311	Tree	15.25			
1337	188985.803	2462946.242	3.412	Tree	14.58			
1338	188983.997	2462940.587	3.411	Tree	14.65			
1339	189136.864	2463419.109	3.241	Tree	13.87			
1340	189137.981	2463422.605	3.242	Tree	12.254			
1341	189356.556	2464106.812	3.211	Tree	13.25			
1342	189357.628	2464110.167	3.213	Tree	14.25			
1343	194188.581	2478655.559	2.732	Tree	14.36			
1344	194189.512	2478648.713	2.754	Tree	12.32			
1345	194247.231	2478114.96	2.621	Tree	15.25			
1346	194247.398	2478108.184	2.654	Tree	14.58			
1347	191282.622	2469331.155	3.121	Tree	14.65			
1348	191285.219	2469334.984	3.12	Tree	13.87			
1349	191363.536	2469450.404	3.14	Tree	12.254			
1350	191364.913	2469452.434	3.141	Tree	13.25			
1351	192231.369	2471134.942	3.141	Tree	14.25			
1352	193416.017	2473785.003	3.212	Tree	14.36			
1353	193584.719	2475186.26	3.33	Tree	12.32			
1354	193571.203	2474786.292	2.985	Tree	15.25			
1355	193560.814	2474478.869	2.598	Tree	14.58			
1356	197010.567	2484028.763	3.312	Tree	14.65			
1357	197015.319	2484031.298	3.311	Tree	13.87			
1358	196031.086	2483301.938	2.932	Tree	12.254			
1359	195472.805	2482746.555	3.31	Tree	13.25			
1360	195476.06	2482748.905	3.312	Tree	14.25			
1361	197229.38	2484717.404	3.122	Tree	14.36			
1362	197227.761	2484706.669	3.121	Tree	12.32			
1363	197577.664	2486881.204	3.515	Tree	15.25			
1364	198363.619	2488589.694	3.621	Tree	14.58			
1365	198366.341	2488596.453	3.62	Tree	14.65			
1366	194270.831	2477158.334	2.365	Tree	13.87			
1367	194270.626	2477161.968	2.395	Tree	12.254			

Kachua-Matlab(N)132kV Double Circuit Transmission Line.								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1	258243.161	2591293.537	3.857	Proposed Gantry		101		6.6
2	258204.76	2591394.520	2.458	AP No. 1		101	76°38'19"RT	6.6
3	258474.235	2591577.528	2.385	AP No. 2		101	12°17'0"RT	6.6
4	258928.854	2591760.268	2.485	AP No. 3		101	47°2'14"RT	6.6
5	259150.428	2591656.290	2.402	AP No. 4		101	25°55'34"LT	6.6
6	260267.667	2591671.634	2.501	AP No. 5		101	51°54'36"RT	6.6
7	260624.071	2591229.571	2.536	AP No. 6		101	37°15'10"LT	6.6
8	262487.875	2590767.343	2.562	AP No. 7		101	31°23'20"RT	6.6
9	262834.442	2590417.624	2.302	AP No. 8		101	22°48'42"LT	6.6
10	263704.787	2590058.048	2.365	AP No. 9		101	42°47'14"RT	6.6
11	263963.722	2589496.763	2.452	AP No. 10		101	29°49'15"LT	6.6
12	264267.386	2589280.848	2.52	AP No. 11		101	41°21'41"LT	6.6
13	264463.6	2589301.288	2.620	AP No. 12		101	33°30'5"RT	6.6
14	265611.007	2588702.608	2.502	AP No. 13		101	37°32'37"RT	6.6
15	265994.357	2587876.834	2.602	AP No. 14		101	35°45'9"LT	6.6
16	266725.065	2587466.019	2.521	AP No. 15		101	26°42'55"RT	6.6
17	267350.403	2586536.801	3.025	AP No. 16		101	43°41'48"LT	6.6
18	268673.828	2586246.698	3.702	AP No. 17		101	21°30'10"RT	6.6
19	269211.4937	2585885.9220	3.954	AP No. 18		101	29°17'9" RT	6.6
20	269566.9857	2585183.4812	3.925	AP No. 19		101	33°34'49" LT	6.6
21	270218.0402	2584814.0889	4.210	AP No. 20		101	31°22'20" LT	6.6
22	270477.0409	2584822.6784	4.274	AP No. 21		101	32°55'58" RT	6.6
23	270963.5684	2584528.8079	4.201	AP No. 22		101	46°29'41" RT	6.6
24	271148.399	2583686.4299	4.202	AP No. 23		101	51°45'3" LT	6.6
25	271670.4364	2583433.3297	4.263	AP No. 24		101	30°59'14" RT	6.6
26	272516.2198	2582137.4827	4.296	AP No. 25		101	52°22'30" RT	6.6
27	272287.6723	2581303.6502	4.352	AP No. 26		101	5°52'27"LT	6.6
28	2581303.65	2581303.510	4.365	AP No. 27		101	38°5'55"LT	6.6
29	273276.6864	2579157.7936	3.920	AP No. 28		101	57°27'58" LT	6.6
30	273985.6918	2579035.2624	3.720	AP No. 29		101	24°48'3" RT	6.6
31	274951.1473	2578315.4977	3.442	AP No. 30		101	24°17'23" LT	6.6
32	275427.6936	2578210.8533	3.326	AP No. 31		101	53°24'0" LT	6.6
33	275817.9797	2578550.1620	3.596	AP No. 32		101	42°8'6" RT	6.6
34	276969.4499	2578526.8926	3.862	AP No. 33		101	50°45'31" RT	6.6
35	277974.8849	2577246.4418	3.802	AP No. 34		101	40°4'56"LT	6.6
36	278444.7346	2577148.0450	3.869	AP No. 35		101	44°13'33" RT	6.6
37	279127.9906	2576134.0941	3.625	AP No. 36		101	12°58'58" RT	6.6
38	279458.7499	2575271.7499	3.562	AP No. 37		101	47°7'14" LT	6.6
39	279942.2159	2575077.3869	3.396	AP No. 38		101	23°54'17"LT	6.6
40	280343.7771	2575091.5310	3.352	AP No. 39		101	12°47'40"RT	6.6
41	281133.6705	2574941.1248	3.330	AP No. 40		101	42°37'5"RT	6.6
42	281231.3754	2574809.5709	3.302	AP No. 41		101	9°8'6" RT	6.6
43	281389.3578	2574505.6502	3.265	TT No-2		101	68°27'12"LT	6.6
44	281488.8246	2574515.963	3.251	Proposed Gantry		101		6.6
45	258221.107	2591351.533	2.452	RL		200		6.6
46	258208.078	2591396.773	2.532	RL		200		6.6
47	258249.441	2591424.864	2.574	RL		200		6.6
48	258290.804	2591452.955	2.465	RL		200		6.6
49	258332.167	2591481.046	2.302	RL		200		6.6
50	258373.53	2591509.137	2.421	RL		200		6.6
51	258417.65	2591539.1	2.532	RL		200		6.6
52	258456.256	2591565.318	2.385	RL		200		6.6
53	258593.247	2591625.367	2.652	RL		200		6.6
54	258639.64	2591644.015	2.452	RL		200		6.6
55	258686.032	2591662.663	2.362	RL		200		6.6
56	258732.424	2591681.311	2.302	RL		200		6.6
57	258963.522	2591743.999	2.352	RL		200		6.6
58	259008.786	2591722.758	2.421	RL		200		6.6
59	259054.05	2591701.517	2.321	RL		200		6.6
60	259099.314	2591680.276	2.362	RL		200		6.6
61	259144.578	2591659.035	2.425	RL		200		6.6
62	259193.962	2591656.888	2.485	RL		200		6.6
63	259243.957	2591657.575	2.532	RL		200		6.6
64	259293.952	2591658.261	2.454	RL		200		6.6
65	259343.947	2591658.948	2.365	RL		200		6.6
66	259393.943	2591659.634	2.321	RL		200		6.6
67	259443.938	2591660.321	2.245	RL		200		6.6
68	259493.933	2591661.008	2.321	RL		200		6.6
69	259543.929	2591661.694	2.365	RL		200		6.6
70	259578.86	2591662.174	2.468	RL		200		6.6
71	259644.381	2591663.074	2.574	RL		200		6.6
72	265496.789	2588762.204	2.532	RL		200		6.6
73	265541.118	2588739.074	2.465	RL		200		6.6
74	265585.446	2588715.945	2.385	RL		200		6.6
75	265619.921	2588683.408	2.421	RL		200		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
76	265641.659	2588636.581	2.562	RL		200		6.6
77	265662.028	2588592.705	2.396	RL		200		6.6
78	265683.081	2588547.353	2.352	RL		200		6.6
79	265704.135	2588502.002	2.401	RL		200		6.6
80	265725.188	2588456.65	2.452	RL		200		6.6
81	265746.242	2588411.299	2.395	RL		200		6.6
82	265767.295	2588365.948	2.352	RL		200		6.6
83	265788.349	2588320.596	2.245	RL		200		6.6
84	265809.402	2588275.245	2.332	RL		200		6.6
85	265872.563	2588139.191	2.421	RL		200		6.6
86	265893.616	2588093.839	2.385	RL		200		6.6
87	265914.67	2588048.488	2.345	RL		200		6.6
88	265935.723	2588003.136	2.401	RL		200		6.6
89	265956.777	2587957.785	2.458	RL		200		6.6
90	265977.83	2587912.434	2.542	RL		200		6.6
91	266003.728	2587871.565	2.632	RL		200		6.6
92	266047.313	2587847.061	2.532	RL		200		6.6
93	266090.897	2587822.558	2.578	RL		200		6.6
94	266134.481	2587798.054	2.712	RL		200		6.6
95	266178.065	2587773.55	2.698	RL		200		6.6
96	266221.649	2587749.047	2.754	RL		200		6.6
97	266352.401	2587675.536	2.532	RL		200		6.6
98	266395.985	2587651.032	2.574	RL		200		6.6
99	266483.153	2587602.025	2.754	RL		200		6.6
100	266526.738	2587577.522	2.895	RL		200		6.6
101	266613.906	2587528.514	2.695	RL		200		6.6
102	266657.49	2587504.011	2.735	RL		200		6.6
103	266701.074	2587479.507	2.698	RL		200		6.6
104	266765.53	2587405.89	2.312	RL		200		6.6
105	266793.446	2587364.409	2.265	RL		200		6.6
106	266821.362	2587322.927	2.254	RL		200		6.6
107	266849.278	2587281.446	2.302	RL		200		6.6
108	266877.194	2587239.965	2.387	RL		200		6.6
109	266905.11	2587198.483	2.454	RL		200		6.6
110	266926.186	2587167.165	2.574	RL		200		6.6
111	266960.941	2587115.52	2.378	RL		200		6.6
112	266988.857	2587074.039	2.532	RL		200		6.6
113	267016.773	2587032.558	2.465	RL		200		6.6
114	267044.689	2586991.076	2.375	RL		200		6.6
115	267156.352	2586825.151	2.532	RL		200		6.6
116	267184.268	2586783.669	2.574	RL		200		6.6
117	267212.184	2586742.188	2.605	RL		200		6.6
118	267240.1	2586700.706	2.654	RL		200		6.6
119	267268.015	2586659.225	2.754	RL		200		6.6
120	267295.931	2586617.744	2.854	RL		200		6.6
121	267323.847	2586576.262	2.985	RL		200		6.6
122	267352.782	2586536.279	3125	RL		200		6.6
123	267401.622	2586525.573	3.245	RL		200		6.6
124	267450.463	2586514.867	3.421	RL		200		6.6
125	267499.303	2586504.161	3.521	RL		200		6.6
126	268329.589	2586322.159	3.621	RL		200		6.6
127	268378.429	2586311.453	3.685	RL		200		6.6
128	268427.27	2586300.747	3.724	RL		200		6.6
129	268476.11	2586290.041	3.865	RL		200		6.6
130	268524.95	2586279.335	3.754	RL		200		6.6
131	268622.631	2586257.923	3.854	RL		200		6.6
132	268671.472	2586247.217	3.752	RL		200		6.6
133	268713.341	2586220.18	3.852	RL		200		6.6
134	268754.858	2586192.316	3.921	RL		200		6.6
135	268789.515	2586169.057	3.925	RL		200		6.6
136	268837.892	2586136.59	3.758	RL		200		6.6
137	268879.408	2586108.727	3.702	RL		200		6.6
138	268920.925	2586080.864	3.765	RL		200		6.6
139	268962.442	2586053.001	3.821	RL		200		6.6
140	269003.959	2586025.138	3.865	RL		200		6.6
141	269045.476	2585997.275	3.721	RL		200		6.6
142	269086.993	2585969.412	3.765	RL		200		6.6
143	269128.51	2585941.549	3.832	RL		200		6.6
144	269170.027	2585913.686	3.854	RL		200		6.6
145	269211.495	2585885.78	3.921	RL		200		6.6
146	269482.467	2585350.454	3.932	RL		200		6.6
147	269505.048	2585305.844	3.895	RL		200		6.6
148	269527.629	2585261.233	3.754	RL		200		6.6
149	269550.21	2585216.623	3.954	RL		200		6.6
150	269578.192	2585177.162	3.895	RL		200		6.6
151	269621.679	2585152.486	3.854	RL		200		6.6
152	269665.166	2585127.81	3.921	RL		200		6.6
153	269708.652	2585103.134	3.985	RL		200		6.6
154	269752.139	2585078.458	4.021	RL		200		6.6
155	269969.573	2584955.078	3.895	RL		200		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
156	270013.06	2584930.402	4.052	RL		200		6.6
157	270056.546	2584905.726	4.125	RL		200		6.6
158	270232.476	2584815.045	4.263	RL		200		6.6
159	270282.452	2584816.615	4.196	RL		200		6.6
160	270332.427	2584818.186	4.165	RL		200		6.6
161	270397.312	2584820.225	4.125	RL		200		6.6
162	270432.378	2584821.327	4.296	RL		200		6.6
163	270481.595	2584820.001	4.275	RL		200		6.6
164	270524.394	2584794.15	4.274	RL		200		6.6
165	270567.192	2584768.299	4.263	RL		200		6.6
166	270609.991	2584742.448	4.195	RL		200		6.6
167	270652.789	2584716.596	4.265	RL		200		6.6
168	270738.387	2584664.894	4.263	RL		200		6.6
169	270781.185	2584639.043	4.285	RL		200		6.6
170	270823.984	2584613.192	4.185	RL		200		6.6
171	270866.783	2584587.341	4.251	RL		200		6.6
172	270909.581	2584561.49	4.352	RL		200		6.6
173	270952.38	2584535.639	4.254	RL		200		6.6
174	270971.505	2584492.827	4.301	RL		200		6.6
175	270982.219	2584443.988	4.298	RL		200		6.6
176	271014.359	2584297.472	4.285	RL		200		6.6
177	271025.072	2584248.634	4.274	RL		200		6.6
178	271035.786	2584199.795	4.262	RL		200		6.6
179	271046.499	2584150.956	4.251	RL		200		6.6
180	271057.213	2584102.117	4.244	RL		200		6.6
181	271067.926	2584053.279	4.237	RL		200		6.6
182	271078.639	2584004.44	4.221	RL		200		6.6
183	271089.353	2583955.601	4.211	RL		200		6.6
184	271110.78	2583857.924	4.237	RL		200		6.6
185	271121.493	2583809.085	4.244	RL		200		6.6
186	271170.421	2583675.802	4.238	RL		200		6.6
187	271215.408	2583653.98	4.241	RL		200		6.6
188	271260.395	2583632.159	4.253	RL		200		6.6
189	271305.382	2583610.337	4.258	RL		200		6.6
190	271485.329	2583523.05	4.225	RL		200		6.6
191	271530.316	2583501.228	4.232	RL		200		6.6
192	271776.617	2583270.576	4.251	RL		200		6.6
193	271803.949	2583228.708	4.262	RL		200		6.6
194	271831.28	2583186.839	4.271	RL		200		6.6
195	271885.944	2583103.102	4.283	RL		200		6.6
196	271940.607	2583019.364	4.277	RL		200		6.6
197	271967.938	2582977.496	4.271	RL		200		6.6
198	271995.27	2582935.627	4.265	RL		200		6.6
199	272022.602	2582893.758	4.255	RL		200		6.6
200	272049.933	2582851.89	4.247	RL		200		6.6
201	272077.265	2582810.021	4.241	RL		200		6.6
202	272104.597	2582768.153	4.234	RL		200		6.6
203	272159.26	2582684.415	4.233	RL		200		6.6
204	272186.591	2582642.547	4.221	RL		200		6.6
205	272241.255	2582558.809	4.232	RL		200		6.6
206	272295.918	2582475.072	4.241	RL		200		6.6
207	272323.25	2582433.203	4.231	RL		200		6.6
208	272350.581	2582391.335	4.244	RL		200		6.6
209	272377.913	2582349.466	4.251	RL		200		6.6
210	272405.244	2582307.598	4.264	RL		200		6.6
211	272432.576	2582265.729	4.273	RL		200		6.6
212	272487.239	2582181.992	4.286	RL		200		6.6
213	272514.571	2582140.123	4.279	RL		200		6.6
214	272500.822	2582093.248	4.261	RL		200		6.6
215	272455.057	2581962.113	4.252	RL		200		6.6
216	272419.647	2581856.858	4.269	RL		200		6.6
217	272408.09	2581808.212	4.263	RL		200		6.6
218	272396.533	2581759.566	4.251	RL		200		6.6
219	272384.976	2581710.92	4.244	RL		200		6.6
220	272373.418	2581662.274	4.258	RL		200		6.6
221	272361.861	2581613.628	4.265	RL		200		6.6
222	272350.304	2581564.982	4.278	RL		200		6.6
223	272338.747	2581516.336	4.286	RL		200		6.6
224	272327.19	2581467.69	4.281	RL		200		6.6
225	272315.632	2581419.044	4.272	RL		200		6.6
226	272292.518	2581321.752	4.251	RL		200		6.6
227	272384.941	2581093.475	4.235	RL		200		6.6
228	272405.861	2581048.062	4.224	RL		200		6.6
229	272426.781	2581002.649	4.235	RL		200		6.6
230	272447.702	2580957.236	4.247	RL		200		6.6
231	272468.622	2580911.823	4.257	RL		200		6.6
232	272489.542	2580866.41	4.265	RL		200		6.6
233	272510.462	2580820.997	4.271	RL		200		6.6
234	272531.383	2580775.584	4.285	RL		200		6.6
235	272573.223	2580684.758	4.271	RL		200		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
236	272594.144	2580639.345	4.269	RL		200		6.6
237	272615.064	2580593.932	4.261	RL		200		6.6
238	272635.984	2580548.519	4.258	RL		200		6.6
239	272656.905	2580503.106	4.251	RL		200		6.6
240	272677.825	2580457.693	4.263	RL		200		6.6
241	272698.745	2580412.28	4.271	RL		200		6.6
242	272719.666	2580366.867	4.261	RL		200		6.6
243	272740.586	2580321.454	4.255	RL		200		6.6
244	272761.506	2580276.041	4.249	RL		200		6.6
245	272782.427	2580230.628	4.245	RL		200		6.6
246	272803.347	2580185.215	4.231	RL		200		6.6
247	272824.267	2580139.802	4.241	RL		200		6.6
248	272928.869	2579912.737	4.245	RL		200		6.6
249	272949.789	2579867.324	4.251	RL		200		6.6
250	272970.71	2579821.911	4.295	RL		200		6.6
251	272991.63	2579776.498	4.291	RL		200		6.6
252	273012.55	2579731.085	4.289	RL		200		6.6
253	273033.471	2579685.672	4.282	RL		200		6.6
254	273054.391	2579640.259	4.271	RL		200		6.6
255	273075.311	2579594.846	4.261	RL		200		6.6
256	273096.231	2579549.433	4.254	RL		200		6.6
257	273117.152	2579504.02	4.241	RL		200		6.6
258	273138.072	2579458.607	4.231	RL		200		6.6
259	273158.992	2579413.194	4.221	RL		200		6.6
260	273179.913	2579367.781	4.211	RL		200		6.6
261	273200.833	2579322.368	4	RL		200		6.6
262	273221.753	2579276.955	3.996	RL		200		6.6
263	273541.457	2579111.805	3.958	RL		200		6.6
264	273784.469	2579069.653	3.809	RL		200		6.6
265	273984.836	2579034.899	3.72	RL		200		6.6
266	274025.083	2579005.375	3.816	RL		200		6.6
267	274065.181	2578975.507	3.661	RL		200		6.6
268	274105.28	2578945.639	3.635	RL		200		6.6
269	274145.378	2578915.771	3.598	RL		200		6.6
270	274185.477	2578885.902	3.581	RL		200		6.6
271	274225.575	2578856.034	3.574	RL		200		6.6
272	274265.674	2578826.166	3.562	RL		200		6.6
273	274426.068	2578706.693	3.541	RL		200		6.6
274	274466.166	2578676.825	3.532	RL		200		6.6
275	274506.265	2578646.956	3.522	RL		200		6.6
276	274546.363	2578617.088	3.511	RL		200		6.6
277	274586.462	2578587.22	3.505	RL		200		6.6
278	274626.56	2578557.352	3.498	RL		200		6.6
279	274666.659	2578527.483	3.491	RL		200		6.6
280	274706.757	2578497.615	3.483	RL		200		6.6
281	274746.856	2578467.747	3.472	RL		200		6.6
282	274786.954	2578437.879	3.463	RL		200		6.6
283	274907.249	2578348.274	3.451	RL		200		6.6
284	274947.348	2578318.406	3.441	RL		200		6.6
285	274995.347	2578305.845	3.452	RL		200		6.6
286	275044.182	2578295.115	3.462	RL		200		6.6
287	275093.018	2578284.385	3.475	RL		200		6.6
288	275141.853	2578273.656	3.489	RL		200		6.6
289	275190.688	2578262.926	3..492	RL		200		6.6
290	275239.523	2578252.197	3.499	RL		200		6.6
291	275288.358	2578241.467	3.509	RL		200		6.6
292	275337.193	2578230.737	3.518	RL		200		6.6
293	275386.029	2578220.008	3.522	RL		200		6.6
294	275433.233	2578215.67	3.329	RL		200		6.6
295	275470.964	2578248.479	3.533	RL		200		6.6
296	275810.54	2578543.755	3.561	RL		200		6.6
297	275858.113	2578549.435	3.572	RL		200		6.6
298	275908.104	2578548.452	3.581	RL		200		6.6
299	276008.084	2578546.486	3.605	RL		200		6.6
300	276053.252	2578545.598	3.629	RL		200		6.6
301	276108.065	2578544.52	3.611	RL		200		6.6
302	276158.055	2578543.536	3.621	RL		200		6.6
303	276208.046	2578542.553	3.632	RL		200		6.6
304	276258.036	2578541.57	3.641	RL		200		6.6
305	276308.026	2578540.587	3.652	RL		200		6.6
306	276358.017	2578539.604	3.662	RL		200		6.6
307	276557.978	2578535.671	3.642	RL		200		6.6
308	276607.968	2578534.688	3.651	RL		200		6.6
309	276657.959	2578533.705	3.661	RL		200		6.6
310	276707.949	2578532.722	3.672	RL		200		6.6
311	276757.939	2578531.739	3.705	RL		200		6.6
312	276807.93	2578530.756	3.721	RL		200		6.6
313	276957.901	2578527.806	3.758	RL		200		6.6
314	276993.187	2578497.339	3.761	RL		200		6.6
315	277024.049	2578458	3.782	RL		200		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
316	277054.911	2578418.662	3.792	RL		200		6.6
317	277085.773	2578379.323	3.803	RL		200		6.6
318	277116.635	2578339.984	3.815	RL		200		6.6
319	277147.496	2578300.645	3.824	RL		200		6.6
320	277178.358	2578261.306	3.836	RL		200		6.6
321	277209.22	2578221.968	3.845	RL		200		6.6
322	277240.082	2578182.629	3.852	RL		200		6.6
323	277270.944	2578143.29	3.862	RL		200		6.6
324	277301.806	2578103.951	3.872	RL		200		6.6
325	277332.668	2578064.612	3.883	RL		200		6.6
326	277363.53	2578025.274	3.896	RL		200		6.6
327	277394.392	2577985.935	3.909	RL		200		6.6
328	277425.254	2577946.596	3.918	RL		200		6.6
329	277456.116	2577907.257	3.929	RL		200		6.6
330	277486.978	2577867.918	3.935	RL		200		6.6
331	277517.839	2577828.579	3.942	RL		200		6.6
332	277548.701	2577789.241	3.968	RL		200		6.6
333	277579.563	2577749.902	3.952	RL		200		6.6
334	277610.425	2577710.563	3.969	RL		200		6.6
335	277641.287	2577671.224	3.972	RL		200		6.6
336	277672.149	2577631.885	3.987	RL		200		6.6
337	277703.011	2577592.547	3.992	RL		200		6.6
338	277764.735	2577513.869	3.934	RL		200		6.6
339	277795.597	2577474.53	3.929	RL		200		6.6
340	277857.321	2577395.853	3.929	RL		200		6.6
341	277888.182	2577356.514	3.92	RL		200		6.6
342	277919.044	2577317.175	3.911	RL		200		6.6
343	277949.906	2577277.836	3.902	RL		200		6.6
344	277984.342	2577244.251	3.895	RL		200		6.6
345	278033.285	2577234.024	3.888	RL		200		6.6
346	278180.113	2577203.342	3.877	RL		200		6.6
347	278326.942	2577172.66	3.868	RL		200		6.6
348	278375.884	2577162.432	3.852	RL		200		6.6
349	278424.827	2577152.205	3.847	RL		200		6.6
350	278461.31	2577123.445	3.832	RL		200		6.6
351	278489.248	2577081.979	3.822	RL		200		6.6
352	278517.187	2577040.514	3.841	RL		200		6.6
353	278545.126	2576999.048	3.852	RL		200		6.6
354	278573.065	2576957.582	3.844	RL		200		6.6
355	278601.004	2576916.116	3.836	RL		200		6.6
356	278628.943	2576874.65	3.822	RL		200		6.6
357	278656.882	2576833.184	3.811	RL		200		6.6
358	278684.821	2576791.718	3.805	RL		200		6.6
359	278712.76	2576750.252	3.791	RL		200		6.6
360	278740.699	2576708.787	3.685	RL		200		6.6
361	278768.637	2576667.321	3.681	RL		200		6.6
362	278796.576	2576625.855	3.676	RL		200		6.6
363	278824.515	2576584.389	3.672	RL		200		6.6
364	278852.454	2576542.923	3.659	RL		200		6.6
365	278880.393	2576501.457	3.655	RL		200		6.6
366	278908.332	2576459.991	3.651	RL		200		6.6
367	278936.271	2576418.526	3.645	RL		200		6.6
368	278992.149	2576335.594	3.632	RL		200		6.6
369	279020.088	2576294.128	3.625	RL		200		6.6
370	279048.026	2576252.662	3.619	RL		200		6.6
371	279075.965	2576211.196	3.615	RL		200		6.6
372	279103.904	2576169.73	3.605	RL		200		6.6
373	279130.442	2576127.536	3.596	RL		200		6.6
374	279148.351	2576080.853	3.592	RL		200		6.6
375	279166.26	2576034.17	3.588	RL		200		6.6
376	279184.169	2575987.488	3.583	RL		200		6.6
377	279255.805	2575800.757	3.579	RL		200		6.6
378	279273.714	2575754.075	3.575	RL		200		6.6
379	279309.532	2575660.709	3.571	RL		200		6.6
380	279327.441	2575614.027	3.566	RL		200		6.6
381	279363.259	2575520.662	3.555	RL		200		6.6
382	279381.168	2575473.979	3.551	RL		200		6.6
383	279399.077	2575427.296	3.547	RL		200		6.6
384	279434.895	2575333.931	3.524	RL		200		6.6
385	279452.804	2575287.248	3.512	RL		200		6.6
386	279721.644	2575166.016	3.468	RL		200		6.6
387	279768.038	2575147.374	3.437	RL		200		6.6
388	279814.433	2575128.732	3.419	RL		200		6.6
389	279860.828	2575110.09	3.408	RL		200		6.6
390	279907.223	2575091.448	3.392	RL		200		6.6
391	279954.5	2575077.844	3.389	RL		200		6.6
392	280004.469	2575079.601	3.382	RL		200		6.6
393	280354.075	2575089.57	3.358	RL		200		6.6
394	280403.192	2575080.218	3.345	RL		200		6.6
395	280652.67	2575032.714	3.362	RL		200		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
396	280747.015	2575014.749	3.335	RL		200		6.6
397	280796.132	2575005.397	3.321	RL		200		6.6
398	280845.25	2574996.044	3.311	RL		200		6.6
399	280894.367	2574986.691	3.302	RL		200		6.6
400	280943.485	2574977.339	3.298	RL		200		6.6
401	280992.602	2574967.986	3.295	RL		200		6.6
402	281137.485	2574935.989	3.285	RL		200		6.6
403	281167.297	2574895.849	3.281	RL		200		6.6
404	281197.109	2574855.709	3.279	RL		200		6.6
405	281226.921	2574815.568	3.274	RL		200		6.6
406	281320.174	2574638.743	3.278	RL		200		6.6
407	281386.196	2574511.733	3.261	RL		200		6.6
408	281439.091	2574510.807	3.258	RL		200		6.6
409	281488.825	2574515.963	3.251	RL		200		6.6
410	281269.389	2574736.442	3.285	RL		200		6.6
411	281240.624	2574792.583	3.292	RL		200		6.6
412	281244.064	2574785.161	3.288	RL		200		6.6
413	280495.498	2575062.641	3.378	RL		200		6.6
414	280319.843	2575090.799	3.374	RL		200		6.6
415	280311.99	2575090.476	3.378	RL		200		6.6
416	278271.997	2577184.141	3.855	RL		200		6.6
417	278264.828	2577185.639	3.861	RL		200		6.6
418	277630.748	2577684.658	3.985	RL		200		6.6
419	277623.74	2577693.591	3.984	RL		200		6.6
420	276734.362	2578532.212	3.692	RL		200		6.6
421	276046.684	2578545.727	3.625	RL		200		6.6
422	273563.453	2579107.989	3.968	RL		200		6.6
423	274274.213	2578819.805	3.533	RL		200		6.6
424	276489.595	2578537.016	3.688	RL		200		6.6
425	276728.117	2578532.325	3.692	RL		200		6.6
426	277818.648	2577445.147	3.982	RL		200		6.6
427	272364.029	2581138.87	4.266	RL		200		6.6
428	272444.236	2581931.107	4.271	RL		200		6.6
429	271564.658	2583484.57	4.271	RL		200		6.6
430	271575.001	2583479.553	4.268	RL		200		6.6
431	272222.98	2582586.804	4.287	RL		200		6.6
432	273366.678	2579142.121	3.978	RL		200		6.6
433	273343.225	2579146.189	3.984	RL		200		6.6
434	273271.4	2579169.185	3.981	RL		200		6.6
435	272896.546	2579982.902	4.985	RL		200		6.6
436	271054.144	2584116.106	4.274	RL		200		6.6
437	268781.89	2586174.174	3.925	RL		200		6.6
438	270683.767	2584697.886	4.185	RL		200		6.6
439	270404.449	2584820.45	4.296	RL		200		6.6
440	269915.113	2584985.981	4.574	RL		200		6.6
441	269407.82	2585497.926	3.895	RL		200		6.6
442	269430.401	2585453.316	3.754	RL		200		6.6
443	269452.981	2585408.705	3.954	RL		200		6.6
444	269298.913	2585713.079	3.932	RL		200		6.6
445	269352.354	2585607.504	3.954	RL		200		6.6
446	269279.794	2585750.851	3.912	RL		200		6.6
447	269218.088	2585872.756	3.895	RL		200		6.6
448	269240.669	2585828.145	3.754	RL		200		6.6
449	269263.25	2585783.535	3.954	RL		200		6.6
450	269348.155	2585615.799	3.895	RL		200		6.6
451	268093.466	2586373.918	3.621	RL		200		6.6
452	268142.307	2586363.212	3.685	RL		200		6.6
453	268191.147	2586352.506	3.724	RL		200		6.6
454	268239.987	2586341.8	3.865	RL		200		6.6
455	268288.828	2586331.094	3.754	RL		200		6.6
456	267857.344	2586425.677	3.621	RL		200		6.6
457	267906.184	2586414.971	3.685	RL		200		6.6
458	267955.024	2586404.265	3.724	RL		200		6.6
459	268003.865	2586393.559	3.865	RL		200		6.6
460	268052.705	2586382.853	3.754	RL		200		6.6
461	266921.82	2587173.652	2.502	RL		200		6.6
462	266579.739	2587547.724	2.954	RL		200		6.6
463	265846.04	2588196.325	2.485	RL		200		6.6
464	265646.764	2588625.585	2.541	RL		200		6.6
465	258236.26	2591311.685	3.685	RL		200		6.6
466	258234.551	2591316.178	3.721	RL		200		6.6
467	258233.831	2591318.072	2.574	RL		200		6.6
468	259568.894	2591662.037	2.452	RL		200		6.6
469	259603.204	2591662.508	2.532	RL		200		6.6
470	259608.835	2591662.586	0.621	RL		200		6.6
471	259617.655	2591662.707	-1.954	RL		200		6.6
472	259627.367	2591662.84	-1.854	RL		200		6.6
473	259637.402	2591662.978	0.325	RL		200		6.6
474	259692.348	2591663.733	2.485	RL		200		6.6
475	259742.343	2591664.419	2.532	RL		200		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
476	259792.338	2591665.106	2.454	RL		200		6.6
477	259842.333	2591665.793	2.365	RL		200		6.6
478	259892.329	2591666.479	2.321	RL		200		6.6
479	259942.324	2591667.166	2.245	RL		200		6.6
480	259992.319	2591667.852	2.321	RL		200		6.6
481	260042.315	2591668.539	2.365	RL		200		6.6
482	260107.489	2591669.434	2.485	RL		200		6.6
483	260157.484	2591670.121	2.532	RL		200		6.6
484	260207.48	2591670.807	2.454	RL		200		6.6
485	260257.475	2591671.494	2.365	RL		200		6.6
486	260279.129	2591657.416	2.485	RL		200		6.6
487	260310.512	2591618.491	2.532	RL		200		6.6
488	260341.894	2591579.567	2.454	RL		200		6.6
489	260373.277	2591540.642	2.365	RL		200		6.6
490	260404.659	2591501.717	2.321	RL		200		6.6
491	260436.041	2591462.792	2.245	RL		200		6.6
492	260467.424	2591423.867	2.321	RL		200		6.6
493	260539.717	2591334.2	2.485	RL		200		6.6
494	260571.099	2591295.275	2.532	RL		200		6.6
495	260602.482	2591256.35	2.454	RL		200		6.6
496	260642.968	2591222.902	2.485	RL		200		6.6
497	260691.51	2591210.916	2.532	RL		200		6.6
498	260740.052	2591198.93	2.454	RL		200		6.6
499	260788.594	2591186.943	2.365	RL		200		6.6
500	260837.136	2591174.957	2.321	RL		200		6.6
501	260885.678	2591162.97	2.245	RL		200		6.6
502	260934.22	2591150.984	2.321	RL		200		6.6
503	260982.762	2591138.998	2.365	RL		200		6.6
504	261046.042	2591123.372	2.485	RL		200		6.6
505	261094.584	2591111.386	2.532	RL		200		6.6
506	261143.126	2591099.399	2.454	RL		200		6.6
507	261191.668	2591087.413	2.365	RL		200		6.6
508	261228.08	2591078.422	2.485	RL		200		6.6
509	261276.622	2591066.435	2.532	RL		200		6.6
510	261325.164	2591054.449	2.454	RL		200		6.6
511	261373.706	2591042.462	2.365	RL		200		6.6
512	261422.248	2591030.476	2.321	RL		200		6.6
513	261470.79	2591018.49	2.245	RL		200		6.6
514	261519.332	2591006.503	2.321	RL		200		6.6
515	261567.874	2590994.517	2.365	RL		200		6.6
516	261631.154	2590978.891	2.485	RL		200		6.6
517	261679.696	2590966.905	2.532	RL		200		6.6
518	261728.238	2590954.919	2.454	RL		200		6.6
519	261776.78	2590942.932	2.365	RL		200		6.6
520	261822.512	2590931.64	2.485	RL		200		6.6
521	261871.054	2590919.653	2.532	RL		200		6.6
522	261919.596	2590907.667	2.454	RL		200		6.6
523	262065.222	2590871.708	2.245	RL		200		6.6
524	262113.764	2590859.721	2.321	RL		200		6.6
525	262162.306	2590847.735	2.365	RL		200		6.6
526	262225.585	2590832.109	2.485	RL		200		6.6
527	262274.127	2590820.123	2.532	RL		200		6.6
528	262322.669	2590808.137	2.454	RL		200		6.6
529	262368.596	2590796.796	2.452	RL		200		6.6
530	262406.667	2590787.395	2.485	RL		200		6.6
531	262455.209	2590775.409	2.532	RL		200		6.6
532	262516.026	2590738.936	2.485	RL		200		6.6
533	262551.221	2590703.421	2.532	RL		200		6.6
534	262586.416	2590667.906	2.454	RL		200		6.6
535	262621.611	2590632.39	2.365	RL		200		6.6
536	262656.806	2590596.875	2.321	RL		200		6.6
537	262692.001	2590561.36	2.245	RL		200		6.6
538	262727.196	2590525.845	2.321	RL		200		6.6
539	262762.391	2590490.33	2.365	RL		200		6.6
540	262837.534	2590416.347	2.532	RL		200		6.6
541	262903.614	2590389.046	2.485	RL		200		6.6
542	262949.825	2590369.954	2.532	RL		200		6.6
543	263088.46	2590312.679	2.321	RL		200		6.6
544	263134.671	2590293.587	2.245	RL		200		6.6
545	263287.336	2590230.515	2.485	RL		200		6.6
546	263334.991	2590210.826	2.721	RL		200		6.6
547	263379.759	2590192.331	2.454	RL		200		6.6
548	263425.97	2590173.239	2.365	RL		200		6.6
549	263465.857	2590156.76	2.485	RL		200		6.6
550	263512.068	2590137.668	2.532	RL		200		6.6
551	263558.28	2590118.576	2.454	RL		200		6.6
552	263604.491	2590099.484	2.365	RL		200		6.6
553	263654.238	2590078.932	2.596	RL		200		6.6
554	263696.914	2590061.301	2.245	RL		200		6.6
555	263725.785	2590012.531	2.485	RL		200		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
556	263746.73	2589967.13	2.532	RL		200		6.6
557	263767.675	2589921.728	2.454	RL		200		6.6
558	263788.62	2589876.326	2.365	RL		200		6.6
559	263809.565	2589830.925	2.321	RL		200		6.6
560	263830.509	2589785.523	2.245	RL		200		6.6
561	263851.454	2589740.121	2.321	RL		200		6.6
562	263872.399	2589694.72	2.365	RL		200		6.6
563	263899.703	2589635.534	2.485	RL		200		6.6
564	263920.648	2589590.132	2.532	RL		200		6.6
565	263941.593	2589544.73	2.454	RL		200		6.6
566	263962.538	2589499.329	2.365	RL		200		6.6
567	263979.299	2589485.687	2.485	RL		200		6.6
568	264020.049	2589456.713	2.532	RL		200		6.6
569	264060.798	2589427.739	2.454	RL		200		6.6
570	264101.547	2589398.765	2.365	RL		200		6.6
571	264142.296	2589369.791	2.321	RL		200		6.6
572	264483.68	2589290.812	2.532	RL		200		6.6
573	264616.666	2589221.424	2.321	RL		200		6.6
574	264660.994	2589198.295	2.245	RL		200		6.6
575	264705.323	2589175.165	2.321	RL		200		6.6
576	264749.652	2589152.036	2.365	RL		200		6.6
577	264807.439	2589121.884	2.485	RL		200		6.6
578	264851.768	2589098.755	2.532	RL		200		6.6
579	264896.097	2589075.626	2.454	RL		200		6.6
580	264940.425	2589052.496	2.365	RL		200		6.6
581	264973.677	2589035.147	2.485	RL		200		6.6
582	265018.006	2589012.017	2.532	RL		200		6.6
583	265062.335	2588988.888	2.454	RL		200		6.6
584	265106.663	2588965.759	2.365	RL		200		6.6
585	265150.992	2588942.629	2.321	RL		200		6.6
586	265195.321	2588919.5	2.245	RL		200		6.6
587	265239.649	2588896.371	2.321	RL		200		6.6
588	265283.978	2588873.242	2.365	RL		200		6.6
589	260516.161	2591363.417	2.465	RL		200		6.6
590	260523.35	2591354.499	2.365	RL		200		6.6
591	261612.231	2590983.564	2.365	RL		200		6.6
592	261619.135	2590981.859	2.365	RL		200		6.6
593	262375.755	2590795.028	2.42	RL		200		6.6
594	263324.181	2590215.292	2.632	RL		200		6.6
595	263646.242	2590082.235	2.574	RL		200		6.6
596	264382.603	2589292.851	2.754	RL		200		6.6
597	264435.113	2589298.321	2.532	RL		200		6.6
598	281263.171	2574748.403	3.285	RL		200		6.6
599	281286.441	2574703.637	3.271	33 kV Line Ht.	12.33	33		6.6
600	269820.668	2585039.572	3.985	11 kV Line Ht.	9.5	11		6.6
601	270106.263	2584877.515	4.175	11 kV Line Ht.	9.5	11		6.6
602	271647.887	2583444.198	4.254	11 kV Line Ht.	9.5	11		6.6
603	272301.426	2581359.249	4.262	11 kV Line Ht.	9.5	11		6.6
604	272304.001	2581269.176	4.247	11 kV Line Ht.	9.5	11		6.6
605	273299.356	2579153.798	3.975	11 kV Line Ht.	9.5	11		6.6
606	275982.129	2578546.996	3.595	11 kV Line Ht.	9.5	11		6.6
607	276405.555	2578538.669	3.675	11 kV Line Ht.	9.5	11		6.6
608	276495.411	2578536.902	3.637	11 kV Line Ht.	9.5	11		6.6
609	277733.309	2577553.927	4	11 kV Line Ht.	9.5	11		6.6
610	279346.092	2575565.41	3.561	11 kV Line Ht.	9.5	11		6.6
611	281085.652	2574950.268	4.251	11 kV Line Ht.	9.5	11		6.6
612	281272.083	2574731.259	3.275	11 kV Line Ht.	9.5	11		6.6
613	280661.106	2575031.107	3.367	11 kV Line Ht.	9.5	11		6.6
614	279210.31	2575919.347	3.531	11 kV Line Ht.	9.5	11		6.6
615	272448.999	2581944.754	4.269	11 kV Line Ht.	9.5	11		6.6
616	272227.645	2582579.658	4.292	11 kV Line Ht.	9.5	11		6.6
617	272466.6	2581995.187	3.241	11 kV Line Ht.	9.5	11		6.6
618	275729.011	2578472.861	1.105	11 kV Line Ht.	9.5	11		6.6
619	271130.177	2583769.5	4.272	11 kV Line Ht.	9.5	11		6.6
620	269993.699	2584941.388	4.754	11 kV Line Ht.	9.5	11		6.6
621	269924.327	2584980.752	3.9521	11 kV Line Ht.	9.5	11		6.6
622	269463.889	2585387.157	5.142	11 kV Line Ht.	9.5	11		6.6
623	269380.003	2585552.88	3.912	11 kV Line Ht.	9.5	11		6.6
624	270993.964	2584390.446	5.932	11 kV Line Ht.	9.5	11		6.6
625	272212.04	2582603.562	4.285	11 kV Line Ht.	9.5	11		6.6
626	272894.653	2579987.012	6.254	11 kV Line Ht.	9.5	11		6.6
627	273718.063	2579081.172	3.874	11 kV Line Ht.	9.5	11		6.6
628	279586.538	2575220.303	4.125	11 kV Line Ht.	9.5	11		6.6
629	280378.145	2575084.987	3.395	11 kV Line Ht.	9.5	11		6.6
630	280372.098	2575086.138	3.362	11 kV Line Ht.	9.5	11		6.6
631	281104.569	2574946.666	3.584	11 kV Line Ht.	9.5	11		6.6
632	281267.78	2574739.538	3.285	11 kV Line Ht.	9.5	11		6.6
633	278267.272	2577185.128	5.863	11 kV Line Ht.	9.5	11		6.6
634	273718.313	2579081.128	4.721	Bridge		90		6.6
635	273723.617	2579080.208	4.754	Bridge		90		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
636	279579.173	2575223.263	4.125	Boundary Wall				6.6
637	280696.347	2575024.397	3.346	CUMILLA-CHANDPUR 132kV TL	27.512	132		6.6
638	267080.875	2586937.305	2.432	DHONAGODA RIVER		25		6.6
639	267120.974	2586877.72	0.254	DHONAGODA RIVER		25		6.6
640	267125.729	2586870.655	2.485	DHONAGODA RIVER		25		6.6
641	267562.757	2586490.252	3.685	DHONAGODA RIVER		25		6.6
642	267596.984	2586482.749	1.025	DHONAGODA RIVER		25		6.6
643	267645.824	2586472.043	-2.354	DHONAGODA RIVER		25		6.6
644	267694.664	2586461.337	-5.36	DHONAGODA RIVER		25		6.6
645	267743.505	2586450.631	-2.354	DHONAGODA RIVER		25		6.6
646	267792.345	2586439.925	1.254	DHONAGODA RIVER		25		6.6
647	267817.457	2586434.42	3.721	DHONAGODA RIVER		25		6.6
648	267114.579	2586887.223	-2.352	DHONAGODA RIVER		25		6.6
649	267105.862	2586900.176	-5.685	DHONAGODA RIVER		25		6.6
650	267097.683	2586912.329	-5.612	DHONAGODA RIVER		25		6.6
651	267091.874	2586920.961	-2.312	DHONAGODA RIVER		25		6.6
652	267084.843	2586931.409	0.352	DHONAGODA RIVER		25		6.6
653	270190.179	2584829.898	4.295	Ditch		70		6.6
654	271099.828	2583907.85	4.125	Ditch		70		6.6
655	271140.624	2583721.873	4.231	Ditch		70		6.6
656	272347.453	2581174.851	4.221	Ditch		70		6.6
657	273689.25	2579086.169	3.925	Ditch		70		6.6
658	274389.795	2578733.712	3.553	Ditch		70		6.6
659	275755.744	2578496.107	3.556	Ditch		70		6.6
660	273901.088	2579049.425	3.854	Ditch		70		6.6
661	273876.664	2579053.662	3.758	Ditch		70		6.6
662	273880.237	2579053.042	2.212	Ditch		70		6.6
663	273897.164	2579050.106	2.125	Ditch		70		6.6
664	273887.253	2579051.825	-1.324	Ditch		70		6.6
665	273891.906	2579051.018	-1.362	Ditch		70		6.6
666	274303.067	2578798.313	3.542	Ditch		70		6.6
667	274298.047	2578802.052	1.163	Ditch		70		6.6
668	274279.814	2578815.633	1.152	Ditch		70		6.6
669	274286.068	2578810.975	0.952	Ditch		70		6.6
670	274293.134	2578805.712	0.925	Ditch		70		6.6
671	280308.82	2575090.302	3.331	Ditch		70		6.6
672	280279.216	2575089.261	3.329	Ditch		70		6.6
673	280287.856	2575089.565	1.652	Ditch		70		6.6
674	280295.061	2575089.818	0.758	Ditch		70		6.6
675	280299.973	2575089.991	0.754	Ditch		70		6.6
676	280304.573	2575090.153	1.655	Ditch		70		6.6
677	272545.17	2580745.656	4.264	Ditch		70		6.6
678	272547.64	2580740.293	2.765	Ditch		70		6.6
679	272550.649	2580733.763	1.748	Ditch		70		6.6
680	272553.714	2580727.109	1.744	Ditch		70		6.6
681	272556.001	2580722.143	2.758	Ditch		70		6.6
682	272559.499	2580714.55	4.251	Ditch		70		6.6
683	272335.894	2581199.943	4.235	Ditch		70		6.6
684	272337.516	2581196.422	3.874	Ditch		70		6.6
685	272343.789	2581182.805	3.869	Ditch		70		6.6
686	272342.211	2581186.23	2.314	Ditch		70		6.6
687	272339.686	2581191.711	2.309	Ditch		70		6.6
688	271128.74	2583776.046	4.234	Ditch		70		6.6
689	271126.669	2583785.488	4.235	Ditch		70		6.6
690	271127.129	2583783.391	2.264	Ditch		70		6.6
691	271128.381	2583777.684	2.274	Ditch		70		6.6
692	271127.817	2583780.255	1.626	Ditch		70		6.6
693	271127.515	2583781.633	1.625	Ditch		70		6.6
694	270192.784	2584828.42	2.985	Ditch		70		6.6
695	270195.278	2584827.005	1.921	Ditch		70		6.6
696	270198.344	2584825.265	1.865	Ditch		70		6.6
697	270200.81	2584823.866	3.125	Ditch		70		6.6
698	270203.306	2584822.45	4.356	Ditch		70		6.6
699	260490.23	2591395.58	2.425	Ditch		70		6.6
700	260493.059	2591392.071	1.021	Ditch		70		6.6
701	260496.591	2591387.69	-1.321	Ditch		70		6.6
702	260501.297	2591381.853	-1.354	Ditch		70		6.6
703	260505.826	2591376.236	0.874	Ditch		70		6.6
704	260509.976	2591371.088	2.365	Ditch		70		6.6
705	271097.409	2583918.875	4.185	Ditch		70		6.6
706	271098.267	2583914.964	3.245	Ditch		70		6.6
707	271098.991	2583911.665	3.125	Ditch		70		6.6
708	271136.854	2583739.062	4.125	Ditch		70		6.6
709	271138.065	2583733.538	3.395	Ditch		70		6.6
710	271138.94	2583729.548	3.125	Ditch		70		6.6
711	271139.828	2583725.504	3.235	Ditch		70		6.6
712	272480.148	2582034.008	4.125	Ditch		70		6.6
713	272478.861	2582030.319	4.125	Ditch		70		6.6
714	273693.586	2579085.417	2.124	Ditch		70		6.6
715	273700.332	2579084.247	1.321	Ditch		70		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
716	273706.271	2579083.217	2.25	Ditch		70		6.6
717	273712.163	2579082.195	3.925	Ditch		70		6.6
718	274309.919	2578793.209	3.542	Ditch		70		6.6
719	274315.923	2578788.736	3.485	Ditch		70		6.6
720	274318.814	2578786.583	3.542	Ditch		70		6.6
721	274328.554	2578779.328	3.254	Ditch		70		6.6
722	274325.576	2578781.547	2.365	Ditch		70		6.6
723	274322.667	2578783.713	2.25	Ditch		70		6.6
724	274313.74	2578790.362	2.421	Ditch		70		6.6
725	274311.89	2578791.74	2.3.5	Ditch		70		6.6
726	274392.447	2578731.801	3.553	Ditch		70		6.6
727	275750.748	2578491.762	3.556	Ditch		70		6.6
728	280670.926	2575029.237	3.315	Ditch		70		6.6
729	280669.255	2575029.556	2.365	Ditch		70		6.6
730	280667.016	2575029.982	1.025	Ditch		70		6.6
731	280665.483	2575030.274	2.325	Ditch		70		6.6
732	280662.153	2575030.908	3.346	Ditch		70		6.6
733	281067.109	2574953.799	3.521	Ditch		70		6.6
734	281074.533	2574952.529	3.584	Ditch		70		6.6
735	274350.71	2578762.825	4.125	GARDEN	12.25	40		6.6
736	280549.129	2575052.429	4.212	GARDEN	14.26	40		6.6
737	280568.222	2575048.794	4.251	GARDEN	15.35	40		6.6
738	266241.331	2587737.981	3.654	GARDEN	12.25	40		6.6
739	266242.448	2587737.353	3.562	GARDEN	13.35	40		6.6
740	266247.582	2587734.467	3.521	GARDEN	13.36	40		6.6
741	261953.276	2590899.35	3.854	GARDEN	14.25	40		6.6
742	262002.36	2590887.23	3.812	GARDEN	13.36	40		6.6
743	264293.853	2589283.605	3.854	GARDEN	15.24	40		6.6
744	264373.952	2589291.949	3.754	GARDEN	12.25	40		6.6
745	274340.718	2578770.267	4.125	GARDEN	14.26	40		6.6
746	275654.351	2578407.941	3.599	GRAVEYARD		210		6.6
747	273469.818	2579124.231	3.921	GRAVEYARD		210		6.6
748	273441.469	2579129.148	3.998	GRAVEYARD		210		6.6
749	275649.527	2578403.746	3.599	GRAVEYARD		210		6.6
750	281353.982	2574573.705	3.265	Haziganj - Chowmuhuni 230kV TL.	27.532	230		6.6
751	272468.564	2582000.814	5.854	HBB Road		65		6.6
752	272469.693	2582004.05	5.865	HBB Road		65		6.6
753	273345.295	2579145.83	4.523	HBB Road		65		6.6
754	273362.183	2579142.9	4.574	HBB Road		65		6.6
755	273302.303	2579153.296	4.754	HBB Road		65		6.6
756	273305.258	2579152.774	4.765	HBB Road		65		6.6
757	273269.109	2579173.881	5.201	HBB Road		65		6.6
758	273270.675	2579170.759	5.254	HBB Road		65		6.6
759	269922.008	2584982.068	4.795	HBB Road		65		6.6
760	269917.426	2584984.668	4.754	HBB Road		65		6.6
761	258549.353	2591607.723	3.521	Homestead		6		6.6
762	258796.582	2591707.355	3.958	Homestead		6		6.6
763	258897.138	2591747.519	3.912	Homestead		6		6.6
764	266571.089	2587552.587	3.998	Homestead		6		6.6
765	266751.899	2587426.146	3.542	Homestead		6		6.6
766	269850.6	2585022.588	4.754	Homestead		6		6.6
767	270161.884	2584845.954	5.521	Homestead		6		6.6
768	271004.773	2584341.169	4.923	Homestead		6		6.6
769	271134.216	2583751.084	4.878	Homestead		6		6.6
770	271578.104	2583478.048	4.255	Homestead		6		6.6
771	271620.289	2583457.585	4.266	Homestead		6		6.6
772	272129.074	2582730.656	4.985	Homestead		6		6.6
773	272481.247	2582037.157	4.574	Homestead		6		6.6
774	272844.237	2580096.453	5.384	Homestead		6		6.6
775	273254.445	2579205.989	4.547	Homestead		6		6.6
776	273487.294	2579121.199	4.574	Homestead		6		6.6
777	273612.352	2579099.508	4.354	Homestead		6		6.6
778	273941.796	2579042.364	4.352	Homestead		6		6.6
779	275505.193	2578278.242	4.352	Homestead		6		6.6
780	278100.992	2577219.875	4.352	Homestead		6		6.6
781	278967.635	2576371.977	4.352	Homestead		6		6.6
782	279411.335	2575395.343	4.362	Homestead		6		6.6
783	279667.102	2575187.931	4.525	Homestead		6		6.6
784	280057.504	2575081.466	4.365	Homestead		6		6.6
785	280189.22	2575086.097	4.361	Homestead		6		6.6
786	280221.423	2575087.229	4.421	Homestead		6		6.6
787	280508.338	2575060.196	4.125	Homestead		6		6.6
788	281043.229	2574958.346	4.125	Homestead		6		6.6
789	273569.385	2579106.96	4.254	Homestead		6		6.6
790	280528.339	2575056.388	4.162	Homestead		6		6.6
791	275643.098	2578398.157	4.241	Homestead		6		6.6
792	272361.042	2581145.353	5.741	Homestead		6		6.6
793	272310.97	2581254.047	5.241	Homestead		6		6.6
794	272320.709	2581232.905	5.214	Homestead		6		6.6
795	272470.485	2582006.319	4.754	Homestead		6		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
796	281245.262	2574782.856	4.254	Homestead		6		6.6
797	281261.44	2574751.856	4.325	Homestead		6		6.6
798	272330.182	2581212.342	5.214	Homestead		6		6.6
799	279485.223	2575261.013	4.352	Homestead		6		6.6
800	279238.739	2575845.243	4.251	Homestead		6		6.6
801	279206.335	2575929.708	4.124	Homestead		6		6.6
802	271129.001	2583774.859	4.895	Homestead		6		6.6
803	270995.397	2584383.913	4.854	Homestead		6		6.6
804	270165.574	2584843.86	5.547	Homestead		6		6.6
805	266734.126	2587452.556	3.621	Homestead		6		6.6
806	266567.375	2587554.675	3.987	Homestead		6		6.6
807	258527.195	2591598.816	3.478	Homestead		6		6.6
808	262804.352	2590447.987	3.452	Homestead		6		6.6
809	263002.632	2590348.138	3.624	Homestead		6		6.6
810	263044.661	2590330.774	3.632	Homestead		6		6.6
811	263185.999	2590272.381	3.574	Homestead		6		6.6
812	263212.051	2590261.618	3.595	Homestead		6		6.6
813	264201.942	2589327.381	3.874	Homestead		6		6.6
814	264215.129	2589318.004	3.825	Homestead		6		6.6
815	264530.637	2589266.311	3.754	Homestead		6		6.6
816	264575.164	2589243.078	3.765	Homestead		6		6.6
817	262821.198	2590430.988	3.521	Homestead		6		6.6
818	272116.999	2582749.153	4.865	Homestead		6		6.6
819	272923.986	2579923.338	5.245	Homestead		6		6.6
820	275499.128	2578272.968	4.421	Homestead		6		6.6
821	275777.392	2578514.931	4.574	Homestead		6		6.6
822	276422.661	2578538.452	4.574	Homestead		6		6.6
823	278139.5	2577211.828	4.352	Homestead		6		6.6
824	278207.964	2577197.522	4.352	Homestead		6		6.6
825	278303.141	2577177.633	4.352	Homestead		6		6.6
826	279408.493	2575402.751	4.256	Homestead		6		6.6
827	280239.165	2575087.853	4.421	Homestead		6		6.6
828	280437.075	2575073.766	4.695	Homestead		6		6.6
829	280425.05	2575076.056	4.658	Homestead		6		6.6
830	278967.047	2576372.849	4.352	Homestead		6		6.6
831	281271.141	2574733.071	4.912	Earthen Road		65		6.6
832	281270.098	2574735.078	4.895	Earthen Road		65		6.6
833	281242.76	2574787.474	4.812	Earthen Road		65		6.6
834	281242.163	2574790.471	4.854	Earthen Road		65		6.6
835	280314.051	2575090.486	5.965	Earthen Road		65		6.6
836	280317.053	2575090.591	5.963	Earthen Road		65		6.6
837	279210.524	2575918.788	5.896	Earthen Road		65		6.6
838	277629.463	2577686.296	5.785	Earthen Road		65		6.6
839	277626.644	2577689.89	5.787	Earthen Road		65		6.6
840	276730.678	2578532.275	5.89	Earthen Road		65		6.6
841	276732.684	2578532.175	5.892	Earthen Road		65		6.6
842	276491.088	2578536.987	5.963	Earthen Road		65		6.6
843	276494.532	2578536.919	5.96	Earthen Road		65		6.6
844	276049.904	2578545.663	5.874	Earthen Road		65		6.6
845	276051.923	2578545.624	5.872	Earthen Road		65		6.6
846	274429.497	2578704.139	4.574	Earthen Road		65		6.6
847	274431.796	2578702.426	4.562	Earthen Road		65		6.6
848	273565.299	2579107.669	5.876	Earthen Road		65		6.6
849	273568.224	2579107.162	5.878	Earthen Road		65		6.6
850	277821.232	2577441.854	5.782	Earthen Road		65		6.6
851	277819.772	2577443.714	5.785	Earthen Road		65		6.6
852	272444.973	2581933.218	5.795	Earthen Road		65		6.6
853	272446.991	2581939	5.754	Earthen Road		65		6.6
854	279211.861	2575915.303	5.898	Earthen Road		65		6.6
855	271052.8	2584122.232	5.621	Earthen Road		65		6.6
856	271053.444	2584119.298	5.675	Earthen Road		65		6.6
857	269993.527	2584941.486	5.024	Earthen Road		65		6.6
858	269990.431	2584943.243	5.045	Earthen Road		65		6.6
859	269351.04	2585610.098	4.862	Earthen Road		65		6.6
860	269349.546	2585613.05	4.854	Earthen Road		65		6.6
861	273778.345	2579070.715	4.385	Earthen Road		65		6.6
862	273769.312	2579072.282	4.421	Earthen Road		65		6.6
863	280473.155	2575066.711	5.365	Earthen Road		65		6.6
864	280476.474	2575066.264	5.852	Earthen Road		65		6.6
865	281266.918	2574741.195	4.721	Earthen Road		65		6.6
866	281264.013	2574746.784	4.854	Earthen Road		65		6.6
867	258239.076	2591304.28	2.451	Canal		75		6.6
868	258508.036	2591591.115	2.342	Canal		75		6.6
869	265449.886	2588786.676	2.452	Canal		75		6.6
870	265819.556	2588253.374	2.574	Canal		75		6.6
871	265853.61	2588180.018	2.452	Canal		75		6.6
872	266263.089	2587725.749	2.601	Canal		75		6.6
873	266312.664	2587697.877	2.421	Canal		75		6.6
874	266455.41	2587617.623	2.854	Canal		75		6.6
875	268565.712	2586270.4	3.895	Canal		75		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
876	270713.553	2584679.894	4.285	Canal		75		6.6
877	270993.559	2584392.292	4.247	Canal		75		6.6
878	273728.369	2579079.384	-1.364	Canal		75		6.6
879	277831.374	2577428.926	3.908	Canal		75		6.6
880	280444.057	2575072.436	3.452	Canal		75		6.6
881	281365.159	2574553.45	3.211	Canal		75		6.6
882	281381.14	2574521.571	3.201	Canal		75		6.6
883	281378.069	2574527.689	1.241	Canal		75		6.6
884	281367.976	2574546.688	1.231	Canal		75		6.6
885	281370.5	2574542.096	-1.432	Canal		75		6.6
886	281374.401	2574534.423	-1.365	Canal		75		6.6
887	280767.517	2575010.845	3.311	Canal		75		6.6
888	280773.128	2575009.777	3.302	Canal		75		6.6
889	279089.985	2576190.388	3.581	Canal		75		6.6
890	279095.601	2576182.054	3.585	Canal		75		6.6
891	279094.458	2576183.75	1.354	Canal		75		6.6
892	279091.006	2576188.874	3.581	Canal		75		6.6
893	279092.052	2576187.321	1.081	Canal		75		6.6
894	279093.255	2576185.536	1.085	Canal		75		6.6
895	277821.597	2577441.389	3.941	Canal		75		6.6
896	274432.24	2578701.869	3.421	Canal		75		6.6
897	274439.198	2578697.5	3.452	Canal		75		6.6
898	274437.19	2578698.408	2.254	Canal		75		6.6
899	274433.575	2578701.101	2.125	Canal		75		6.6
900	274434.64	2578700.308	1.021	Canal		75		6.6
901	274435.899	2578699.37	1.352	Canal		75		6.6
902	272811.677	2580167.132	4.211	Canal		75		6.6
903	272817.735	2580153.983	4.221	Canal		75		6.6
904	272816.49	2580156.685	2.625	Canal		75		6.6
905	272812.91	2580164.457	2.635	Canal		75		6.6
906	272814.232	2580161.587	-1.325	Canal		75		6.6
907	272815.357	2580159.144	-1.365	Canal		75		6.6
908	272328.612	2581215.752	4.235	Canal		75		6.6
909	272321.623	2581230.921	4.252	Canal		75		6.6
910	272322.967	2581228.004	2.762	Canal		75		6.6
911	272326.896	2581219.475	2.754	Canal		75		6.6
912	272325.962	2581221.503	1.635	Canal		75		6.6
913	272324.205	2581225.318	1.652	Canal		75		6.6
914	272388.264	2581724.761	4.221	Canal		75		6.6
915	272389.971	2581731.945	4.211	Canal		75		6.6
916	272389.725	2581730.909	2.732	Canal		75		6.6
917	272388.652	2581726.394	2.725	Canal		75		6.6
918	272388.99	2581727.815	1.745	Canal		75		6.6
919	272389.316	2581729.19	1.751	Canal		75		6.6
920	272466.121	2581993.816	4.125	Canal		75		6.6
921	272471.769	2582009.998	4.212	Canal		75		6.6
922	272476.958	2582024.867	4.125	Canal		75		6.6
923	272475.861	2582021.724	2.325	Canal		75		6.6
924	272472.944	2582013.366	2.354	Canal		75		6.6
925	272473.818	2582015.869	-1.352	Canal		75		6.6
926	272474.925	2582019.041	-1.385	Canal		75		6.6
927	272261.741	2582527.427	4.209	Canal		75		6.6
928	272275.411	2582506.486	4.211	Canal		75		6.6
929	272273.616	2582509.236	2.725	Canal		75		6.6
930	272264.878	2582522.621	2.714	Canal		75		6.6
931	272267.678	2582518.332	-1.365	Canal		75		6.6
932	272270.831	2582513.502	-1.312	Canal		75		6.6
933	272215.334	2582598.516	4.208	Canal		75		6.6
934	272221.056	2582589.75	4.232	Canal		75		6.6
935	272219.998	2582591.372	2.711	Canal		75		6.6
936	272216.276	2582597.073	2.708	Canal		75		6.6
937	272217.403	2582595.347	1.732	Canal		75		6.6
938	272218.406	2582593.811	1.725	Canal		75		6.6
939	271855.201	2583150.195	4.245	Canal		75		6.6
940	271866.368	2583133.41	4.265	Canal		75		6.6
941	271863.462	2583137.541	2.762	Canal		75		6.6
942	271857.177	2583147.168	2.763	Canal		75		6.6
943	271859.43	2583143.717	1.621	Canal		75		6.6
944	271861.524	2583140.509	1.632	Canal		75		6.6
945	280768.804	2575010.6	1.251	Canal		75		6.6
946	280771.532	2575010.081	1.258	Canal		75		6.6
947	280769.717	2575010.426	-1.362	Canal		75		6.6
948	280770.598	2575010.259	-1.365	Canal		75		6.6
949	272468.106	2581999.503	4.025	Canal		75		6.6
950	272467.723	2581998.404	3.214	Canal		75		6.6
951	272467.304	2581997.206	1.521	Canal		75		6.6
952	272466.848	2581995.898	1.574	Canal		75		6.6
953	277823.15	2577439.409	2.325	Canal		75		6.6
954	277829.529	2577431.278	2.331	Canal		75		6.6
955	277825.412	2577436.525	1.351	Canal		75		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
956	277827.01	2577434.489	1.344	Canal		75		6.6
957	276505.225	2578536.709	3.608	Canal		75		6.6
958	276498.85	2578536.834	3.611	Canal		75		6.6
959	276499.809	2578536.815	2.338	Canal		75		6.6
960	276503.7	2578536.739	2.341	Canal		75		6.6
961	276501.193	2578536.788	1.125	Canal		75		6.6
962	276502.477	2578536.763	1.108	Canal		75		6.6
963	272958.715	2579847.948	4.233	Canal		75		6.6
964	272964.507	2579835.375	4.251	Canal		75		6.6
965	272963.653	2579837.229	2.711	Canal		75		6.6
966	272960.127	2579844.884	2.709	Canal		75		6.6
967	272961.319	2579842.296	-1.324	Canal		75		6.6
968	272962.588	2579839.54	-1.321	Canal		75		6.6
969	270991.019	2584403.873	4.65	Canal		75		6.6
970	270991.511	2584401.627	2.553	Canal		75		6.6
971	270992.998	2584394.848	2.541	Canal		75		6.6
972	270992.49	2584397.165	1.698	Canal		75		6.6
973	270992.109	2584398.902	1.691	Canal		75		6.6
974	270715.473	2584678.734	3.295	Canal		75		6.6
975	270717.268	2584677.651	1.521	Canal		75		6.6
976	270718.837	2584676.703	1.584	Canal		75		6.6
977	270720.701	2584675.577	3.251	Canal		75		6.6
978	270721.908	2584674.847	4.352	Canal		75		6.6
979	269999.999	2584937.814	3.854	Canal		75		6.6
980	269994.6	2584940.877	3.854	Canal		75		6.6
981	269995.918	2584940.129	2.454	Canal		75		6.6
982	269997.263	2584939.366	0.254	Canal		75		6.6
983	269998.645	2584938.581	2.125	Canal		75		6.6
984	269988.723	2584944.212	3.854	Canal		75		6.6
985	269982.341	2584947.833	3.854	Canal		75		6.6
986	269983.577	2584947.132	2.454	Canal		75		6.6
987	269986.121	2584945.689	0.254	Canal		75		6.6
988	269987.369	2584944.98	2.125	Canal		75		6.6
989	269984.751	2584946.466	0.125	Canal		75		6.6
990	269937.824	2584973.093	3.854	Canal		75		6.6
991	269924.75	2584980.512	3.854	Canal		75		6.6
992	269927.9	2584978.725	2.454	Canal		75		6.6
993	269932.948	2584975.861	0.254	Canal		75		6.6
994	269935.17	2584974.6	2.125	Canal		75		6.6
995	269930.688	2584977.143	0.125	Canal		75		6.6
996	268569.981	2586269.464	1.896	Canal		75		6.6
997	268575.697	2586268.211	0.352	Canal		75		6.6
998	268580.687	2586267.117	0.125	Canal		75		6.6
999	268587.26	2586265.676	2.124	Canal		75		6.6
1000	268592.165	2586264.601	3.921	Canal		75		6.6
1001	266427.422	2587633.359	2.754	Canal		75		6.6
1002	266431.685	2587630.962	0.265	Canal		75		6.6
1003	266436.842	2587628.062	-2.652	Canal		75		6.6
1004	266443.85	2587624.122	-2.62	Canal		75		6.6
1005	266450.12	2587620.597	0.254	Canal		75		6.6
1006	266267.065	2587723.514	1.321	Canal		75		6.6
1007	266272.004	2587720.737	-1.521	Canal		75		6.6
1008	266277.535	2587717.627	-1.541	Canal		75		6.6
1009	266281.811	2587715.223	1.251	Canal		75		6.6
1010	266286.101	2587712.811	2.531	Canal		75		6.6
1011	266290.39	2587710.4	2.485	Canal		75		6.6
1012	266295.42	2587707.572	2.054	Canal		75		6.6
1013	266299.907	2587705.049	1.364	Canal		75		6.6
1014	266304.943	2587702.218	1.854	Canal		75		6.6
1015	266308.995	2587699.94	2.124	Canal		75		6.6
1016	265849.593	2588188.671	2.465	Canal		75		6.6
1017	265850.554	2588186.601	0.257	Canal		75		6.6
1018	265851.413	2588184.751	-2.31	Canal		75		6.6
1019	265852.137	2588183.19	-2.352	Canal		75		6.6
1020	265853.001	2588181.328	0.212	Canal		75		6.6
1021	265824.048	2588243.697	0.321	Canal		75		6.6
1022	265827.302	2588236.686	-2.982	Canal		75		6.6
1023	265831.157	2588228.384	-2.894	Canal		75		6.6
1024	265834.772	2588220.597	0.251	Canal		75		6.6
1025	265838.489	2588212.59	2.532	Canal		75		6.6
1026	265439.685	2588791.999	2.485	Canal		75		6.6
1027	265441.777	2588790.907	0.285	Canal		75		6.6
1028	265444.285	2588789.599	-1.82	Canal		75		6.6
1029	265446.342	2588788.525	-1.874	Canal		75		6.6
1030	265448.127	2588787.594	0.251	Canal		75		6.6
1031	258238.57	2591305.611	0.645	Canal		75		6.6
1032	258238.072	2591306.919	-1.325	Canal		75		6.6
1033	258237.505	2591308.409	0.654	Canal		75		6.6
1034	258236.9	2591310.002	2.512	Canal		75		6.6
1035	258424.897	2591544.022	2.421	Canal		75		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1036	258431.561	2591548.547	2.532	Canal		75		6.6
1037	258430.124	2591547.572	2.351	Canal		75		6.6
1038	258428.722	2591546.619	-1.362	Canal		75		6.6
1039	258427.4	2591545.721	-1.321	Canal		75		6.6
1040	258426.313	2591544.983	1.254	Canal		75		6.6
1041	258518.242	2591595.217	2.31	Canal		75		6.6
1042	258515.944	2591594.294	1.212	Canal		75		6.6
1043	258513.758	2591593.415	-1.384	Canal		75		6.6
1044	258512.045	2591592.727	-1.324	Canal		75		6.6
1045	258510.326	2591592.036	1.242	Canal		75		6.6
1046	263891.968	2589652.302	2.621	Canal		75		6.6
1047	263878.922	2589680.581	2.536	Canal		75		6.6
1048	263881.354	2589675.309	0.385	Canal		75		6.6
1049	263884.222	2589669.092	-1.862	Canal		75		6.6
1050	263887.348	2589662.317	-1.874	Canal		75		6.6
1051	263889.615	2589657.402	0.352	Canal		75		6.6
1052	264391.844	2589293.813	2.687	Canal		75		6.6
1053	264411.87	2589295.899	2.754	Canal		75		6.6
1054	264407.431	2589295.437	0.721	Canal		75		6.6
1055	264403.309	2589295.008	-1.635	Canal		75		6.6
1056	264399.041	2589294.563	-1.587	Canal		75		6.6
1057	264395.429	2589294.187	0.685	Canal		75		6.6
1058	273739.023	2579077.536	-1.364	Canal		75		6.6
1059	273751.051	2579075.45	1.245	Canal		75		6.6
1060	273765.548	2579072.935	3.595	Canal		75		6.6
1061	273714.759	2579081.745	1.251	Canal		75		6.6
1062	273713.153	2579082.023	3.854	Canal		75		6.6
1063	280451.277	2575071.062	1.265	Canal		75		6.6
1064	280457.985	2575069.784	-1.652	Canal		75		6.6
1065	280463.877	2575068.662	-1.695	Canal		75		6.6
1066	280469.369	2575067.617	1.362	Canal		75		6.6
1067	269461.548	2585391.781	3.965	LOW LAND		70		6.6
1068	279294.945	2575698.733	3.625	LOW LAND		70		6.6
1069	279296.762	2575693.995	3.485	LOW LAND		70		6.6
1070	275709.806	2578456.162	3.535	LOW LAND		70		6.6
1071	275691.805	2578440.509	3.522	LOW LAND		70		6.6
1072	275695.633	2578443.838	2.135	LOW LAND		70		6.6
1073	275705.815	2578452.691	2.147	LOW LAND		70		6.6
1074	275699.021	2578446.784	1.232	LOW LAND		70		6.6
1075	275702.693	2578449.977	1.242	LOW LAND		70		6.6
1076	275722.552	2578467.245	3.512	LOW LAND		70		6.6
1077	275734.82	2578477.913	3.511	LOW LAND		70		6.6
1078	275725.186	2578469.536	2.121	LOW LAND		70		6.6
1079	275733.045	2578476.369	2.125	LOW LAND		70		6.6
1080	275730.662	2578474.297	1.11	LOW LAND		70		6.6
1081	269457.578	2585399.624	3.895	LOW LAND		70		6.6
1082	269458.64	2585397.527	2.185	LOW LAND		70		6.6
1083	269459.564	2585395.702	1.251	LOW LAND		70		6.6
1084	269460.697	2585393.463	2.125	LOW LAND		70		6.6
1085	271052.091	2584125.676	4.254	LOW LAND		70		6.6
1086	271052.668	2584122.834	4.215	LOW LAND		70		6.6
1087	271354.945	2583586.296	4.231	Pond		80		6.6
1088	271436.311	2583546.827	4.211	Pond		80		6.6
1089	271748.09	2583314.276	4.241	Pond		80		6.6
1090	271916.995	2583055.535	4.285	Pond		80		6.6
1091	272463.539	2582218.297	4.282	Pond		80		6.6
1092	272435.071	2581904.846	4.236	Pond		80		6.6
1093	272893.175	2579990.22	4.211	Pond		80		6.6
1094	272907.949	2579958.15	4.221	Pond		80		6.6
1095	276458.569	2578537.645	3.611	Pond		80		6.6
1096	276861.942	2578529.694	3.733	Pond		80		6.6
1097	276908.435	2578528.779	3.741	Pond		80		6.6
1098	278137.561	2577212.233	3.832	Pond		80		6.6
1099	278233.849	2577192.113	1.344	Pond		80		6.6
1100	279212.834	2575912.767	3.528	Pond		80		6.6
1101	279236.181	2575851.91	3.551	Pond		80		6.6
1102	279487.901	2575259.937	3.502	Pond		80		6.6
1103	280104.408	2575083.115	-1.652	Pond		80		6.6
1104	280153.775	2575084.851	-1.754	Pond		80		6.6
1105	281248.212	2574776.854	3.225	Pond		80		6.6
1106	281250.871	2574772.066	1.325	Pond		80		6.6
1107	281258.788	2574757.704	1.362	Pond		80		6.6
1108	281252.741	2574768.469	-1.354	Pond		80		6.6
1109	281256.036	2574762.13	-1.364	Pond		80		6.6
1110	280136.843	2575084.365	3.325	Pond		80		6.6
1111	280085.65	2575082.242	3.341	Pond		80		6.6
1112	280095.863	2575082.814	1.244	Pond		80		6.6
1113	280129.973	2575084.014	1.251	Pond		80		6.6
1114	280119.229	2575083.49	-1.695	Pond		80		6.6
1115	280165.852	2575085.275	3.341	Pond		80		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1116	280144.594	2575084.528	3.339	Pond		80		6.6
1117	280149.142	2575084.688	1.425	Pond		80		6.6
1118	280161.706	2575085.129	1.341	Pond		80		6.6
1119	279637.682	2575199.753	3.442	Pond		80		6.6
1120	279604.103	2575213.245	3.436	Pond		80		6.6
1121	279609.596	2575210.939	1.321	Pond		80		6.6
1122	279631.226	2575202.347	1.319	Pond		80		6.6
1123	279616.567	2575208.237	-1.896	Pond		80		6.6
1124	279623.574	2575205.421	-1.758	Pond		80		6.6
1125	279519.465	2575247.254	-1.652	Pond		80		6.6
1126	279230.221	2575867.81	3.533	Pond		80		6.6
1127	279227.392	2575875.183	1.325	Pond		80		6.6
1128	279215.894	2575905.156	1.321	Pond		80		6.6
1129	279219.698	2575894.874	-1.365	Pond		80		6.6
1130	279223.986	2575883.697	-1.421	Pond		80		6.6
1131	278214.929	2577195.84	3.851	Pond		80		6.6
1132	278242.257	2577190.5	3.844	Pond		80		6.6
1133	278238.493	2577191.142	2.311	Pond		80		6.6
1134	278221.05	2577194.787	2.315	Pond		80		6.6
1135	278227.81	2577193.375	1.348	Pond		80		6.6
1136	278104.11	2577219.223	3.84	Pond		80		6.6
1137	278112.048	2577217.565	2.531	Pond		80		6.6
1138	278132.11	2577213.373	2.522	Pond		80		6.6
1139	278118.8	2577216.154	-1.396	Pond		80		6.6
1140	278125.528	2577214.748	-1.362	Pond		80		6.6
1141	276901.326	2578528.919	2.347	Pond		80		6.6
1142	276869.187	2578529.551	2.362	Pond		80		6.6
1143	276880.812	2578529.322	-1.721	Pond		80		6.6
1144	276890.129	2578529.139	-1.652	Pond		80		6.6
1145	276427.302	2578538.218	3.644	Pond		80		6.6
1146	276435.182	2578538.086	2.161	Pond		80		6.6
1147	276452.54	2578537.745	2.168	Pond		80		6.6
1148	276439.585	2578538	-1.325	Pond		80		6.6
1149	276445.419	2578537.885	-1.25	Pond		80		6.6
1150	274831.209	2578404.862	3.441	Pond		80		6.6
1151	274863.413	2578381.036	3.432	Pond		80		6.6
1152	274857.44	2578385.375	1.136	Pond		80		6.6
1153	274837.159	2578400.499	1.152	Pond		80		6.6
1154	274845.125	2578394.895	-1.652	Pond		80		6.6
1155	274851.244	2578389.991	-1.721	Pond		80		6.6
1156	273256.861	2579200.744	3.965	Pond		80		6.6
1157	273268.233	2579176.059	3.977	Pond		80		6.6
1158	273266.231	2579180.336	2.122	Pond		80		6.6
1159	273259.106	2579195.872	2.131	Pond		80		6.6
1160	273261.29	2579191.314	1.352	Pond		80		6.6
1161	273263.594	2579186.129	1.362	Pond		80		6.6
1162	273306.27	2579152.599	3.982	Pond		80		6.6
1163	273334.907	2579147.824	3.978	Pond		80		6.6
1164	273331.024	2579148.408	2.511	Pond		80		6.6
1165	273312.537	2579151.512	2.522	Pond		80		6.6
1166	273318.547	2579150.469	-1.365	Pond		80		6.6
1167	273323.694	2579149.577	-1.396	Pond		80		6.6
1168	273582.824	2579104.629	3.9112	Pond		80		6.6
1169	273610.913	2579099.757	3.925	Pond		80		6.6
1170	273606.074	2579100.597	2.411	Pond		80		6.6
1171	273588.671	2579103.615	2.421	Pond		80		6.6
1172	273595.93	2579102.356	1.425	Pond		80		6.6
1173	273601.41	2579101.405	1.425	Pond		80		6.6
1174	273863.41	2579055.96	3.741	Pond		80		6.6
1175	273797.582	2579067.218	3.254	Pond		80		6.6
1176	273807.667	2579065.629	2.354	Pond		80		6.6
1177	273853.432	2579057.691	2.312	Pond		80		6.6
1178	273823.05	2579062.961	-1.364	Pond		80		6.6
1179	273836.257	2579060.67	-1.364	Pond		80		6.6
1180	279587.043	2575220.1	3.429	Pond		80		6.6
1181	279231.413	2575864.704	3.544	Pond		80		6.6
1182	278281.803	2577182.092	3.849	Pond		80		6.6
1183	278287.001	2577181.006	3.121	Pond		80		6.6
1184	278302.174	2577177.835	3.845	Pond		80		6.6
1185	278300.418	2577178.202	2.23	Pond		80		6.6
1186	278296.326	2577179.057	2.551	Pond		80		6.6
1187	278292.246	2577179.91	2.562	Pond		80		6.6
1188	273407.003	2579135.126	3.965	Pond		80		6.6
1189	273437.033	2579129.917	3.961	Pond		80		6.6
1190	273432.068	2579130.779	3.432	Pond		80		6.6
1191	273414.943	2579133.749	3.425	Pond		80		6.6
1192	273421.738	2579132.57	2.863	Pond		80		6.6
1193	273428.143	2579131.459	2.854	Pond		80		6.6
1194	272117.906	2582747.764	4.211	Pond		80		6.6
1195	272127.798	2582732.61	4.221	Pond		80		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1196	272125.738	2582735.766	2.681	Pond		80		6.6
1197	272119.897	2582744.714	2.687	Pond		80		6.6
1198	272121.772	2582741.842	1.701	Pond		80		6.6
1199	272123.571	2582739.087	1.654	Pond		80		6.6
1200	271727.428	2583345.928	4.221	Pond		80		6.6
1201	271691.114	2583401.556	4.221	Pond		80		6.6
1202	271697.465	2583391.827	2.711	Pond		80		6.6
1203	271721.954	2583354.313	2.741	Pond		80		6.6
1204	271715.307	2583364.496	1.325	Pond		80		6.6
1205	271704.948	2583380.364	1.421	Pond		80		6.6
1206	271581.694	2583476.306	4.211	Pond		80		6.6
1207	271602.035	2583466.44	4.205	Pond		80		6.6
1208	271598.912	2583467.955	3.987	Pond		80		6.6
1209	271585.729	2583474.349	3.985	Pond		80		6.6
1210	271589.838	2583472.356	2.115	Pond		80		6.6
1211	271593.883	2583470.394	2.105	Pond		80		6.6
1212	271604.256	2583465.363	4.201	Pond		80		6.6
1213	271618.716	2583458.348	4.208	Pond		80		6.6
1214	271615.706	2583459.808	2.552	Pond		80		6.6
1215	271606.778	2583464.139	2.542	Pond		80		6.6
1216	271609.714	2583462.715	1.325	Pond		80		6.6
1217	271612.595	2583461.318	1.355	Pond		80		6.6
1218	281260.671	2574753.213	3.221	Pond		80		6.6
1219	280157.974	2575084.998	-1.732	Pond		80		6.6
1220	272429.12	2581887.795	4.232	Pond		80		6.6
1221	272430.32	2581891.231	2.687	Pond		80		6.6
1222	272434.071	2581901.981	2.679	Pond		80		6.6
1223	272431.62	2581894.958	1.695	Pond		80		6.6
1224	272432.808	2581898.362	1.687	Pond		80		6.6
1225	279598.863	2575215.351	3.421	Pond		80		6.6
1226	279539.258	2575239.301	3.251	Pond		80		6.6
1227	279532.49	2575242.02	1.249	Pond		80		6.6
1228	279494.892	2575257.128	1.244	Pond		80		6.6
1229	279505.764	2575252.759	-1.625	Pond		80		6.6
1230	279232.487	2575861.902	2.051	Pond		80		6.6
1231	279235.14	2575854.989	2.056	Pond		80		6.6
1232	279233.494	2575859.28	1.058	Pond		80		6.6
1233	279234.183	2575857.482	1.056	Pond		80		6.6
1234	275688.94	2578438.018	3.521	Pond		80		6.6
1235	275674.932	2578425.838	3.541	Pond		80		6.6
1236	275676.983	2578427.621	3.132	Pond		80		6.6
1237	275685.903	2578435.377	3.112	Pond		80		6.6
1238	275679.497	2578429.807	2.11	Pond		80		6.6
1239	275682.318	2578432.26	2.105	Pond		80		6.6
1240	272923.481	2579924.432	4.208	Pond		80		6.6
1241	272919.635	2579932.783	2.774	Pond		80		6.6
1242	272910.714	2579952.146	2.765	Pond		80		6.6
1243	272913.314	2579946.502	1.752	Pond		80		6.6
1244	272916.807	2579938.92	1.768	Pond		80		6.6
1245	271424.173	2583552.715	2.577	Pond		80		6.6
1246	271366.484	2583580.698	2.585	Pond		80		6.6
1247	271384.73	2583571.848	-1.598	Pond		80		6.6
1248	271401.116	2583563.899	-1.568	Pond		80		6.6
1249	269473.538	2585368.094	3.912	Pond		80		6.6
1250	269465.84	2585383.303	3.895	Pond		80		6.6
1251	269467.09	2585380.833	2.996	Pond		80		6.6
1252	269468.503	2585378.042	1.82	Pond		80		6.6
1253	269470.102	2585374.882	1.856	Pond		80		6.6
1254	269471.688	2585371.75	2.958	Pond		80		6.6
1255	269315.201	2585680.902	3.895	Pond		80		6.6
1256	269325.599	2585660.359	3.754	Pond		80		6.6
1257	269321.561	2585668.338	3.125	Pond		80		6.6
1258	269318.999	2585673.398	2.987	Pond		80		6.6
1259	269316.995	2585677.358	3.057	Pond		80		6.6
1260	262851.632	2590410.522	2.621	Pond		80		6.6
1261	262859.061	2590407.453	1.251	Pond		80		6.6
1262	262867.091	2590404.135	-1.875	Pond		80		6.6
1263	262876.431	2590400.277	-1.921	Pond		80		6.6
1264	262883.322	2590397.43	1.324	Pond		80		6.6
1265	262889.515	2590394.871	2.632	Pond		80		6.6
1266	271746.312	2583317	3.3125	Pond		80		6.6
1267	271744.515	2583319.753	2.365	Pond		80		6.6
1268	271742.579	2583322.718	3.265	Pond		80		6.6
1269	271739.906	2583326.813	4.125	Pond		80		6.6
1270	272467.32	2582212.506	4.282	Pond		80		6.6
1271	272466.454	2582213.832	3.702	Pond		80		6.6
1272	272465.004	2582216.053	3.754	Pond		80		6.6
1273	272879.956	2580018.915	4.125	Pond		80		6.6
1274	272883.994	2580010.15	3.547	Pond		80		6.6
1275	272887.313	2580002.946	2.321	Pond		80		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1276	272889.457	2579998.291	2.321	Pond		80		6.6
1277	272891.666	2579993.495	3.745	Pond		80		6.6
1278	274330.551	2578777.84	3.542	Pond		80		6.6
1279	274340.043	2578770.77	3.485	Pond		80		6.6
1280	274337.288	2578772.822	2.532	Pond		80		6.6
1281	274333.862	2578775.374	2.545	Pond		80		6.6
1282	277658.539	2577649.234	3.987	Pond		80		6.6
1283	277649.332	2577660.97	3.987	Pond		80		6.6
1284	277651.204	2577658.583	2.125	Pond		80		6.6
1285	277653.274	2577655.945	-1.421	Pond		80		6.6
1286	277655.163	2577653.536	-1.354	Pond		80		6.6
1287	277656.973	2577651.23	2.352	Pond		80		6.6
1288	279409.498	2575400.132	3.521	Pond		80		6.6
1289	279410.688	2575397.03	3.485	Pond		80		6.6
1290	279542.292	2575238.082	3.185	Pond		80		6.6
1291	279547.445	2575236.011	3.255	Pond		80		6.6
1292	279595.498	2575216.703	2.702	Pond		80		6.6
1293	279591.689	2575218.234	2.754	Pond		80		6.6
1294	271919.645	2583051.475	4.285	Pond		80		6.6
1295	280655.303	2575032.212	5.887	Pucca Road		60		6.6
1296	280658.787	2575031.549	5.878	Pucca Road		60		6.6
1297	279581.642	2575222.271	5.966	Pucca Road		60		6.6
1298	279585.252	2575220.82	5.968	Pucca Road		60		6.6
1299	278266.405	2577185.31	5.825	Pucca Road		60		6.6
1300	278269.653	2577184.631	5.878	Pucca Road		60		6.6
1301	275645.509	2578400.253	5.124	Pucca Road		60		6.6
1302	275648.686	2578403.015	5.152	Pucca Road		60		6.6
1303	272361.822	2581143.659	6.125	Pucca Road		60		6.6
1304	272363.195	2581140.679	6.124	Pucca Road		60		6.6
1305	271566.652	2583483.603	5.876	Pucca Road		60		6.6
1306	271573.748	2583480.161	5.874	Pucca Road		60		6.6
1307	272223.878	2582585.429	6.124	Pucca Road		60		6.6
1308	272226.314	2582581.697	6.121	Pucca Road		60		6.6
1309	272895.989	2579984.111	6.352	Pucca Road		60		6.6
1310	272894.55	2579987.236	6.321	Pucca Road		60		6.6
1311	271129.174	2583774.07	5.875	Pucca Road		60		6.6
1312	271129.847	2583771.004	5.687	Pucca Road		60		6.6
1313	270994.784	2584386.709	5.912	Pucca Road		60		6.6
1314	270993.67	2584391.784	5.874	Pucca Road		60		6.6
1315	268786.4	2586171.148	5.124	Pucca Road		60		6.6
1316	268784.092	2586172.697	5.142	Pucca Road		60		6.6
1317	270399.432	2584820.292	5.995	Pucca Road		60		6.6
1318	270402.437	2584820.386	5.985	Pucca Road		60		6.6
1319	269464.839	2585385.28	5.121	Pucca Road		60		6.6
1320	269463.267	2585388.386	5.132	Pucca Road		60		6.6
1321	266924.557	2587169.586	4.125	Pucca Road		60		6.6
1322	266923.092	2587171.762	4.152	Pucca Road		60		6.6
1323	266574.477	2587550.682	4.265	Pucca Road		60		6.6
1324	266577.991	2587548.706	4.125	Pucca Road		60		6.6
1325	265848.882	2588190.201	3.865	Pucca Road		60		6.6
1326	265847.225	2588193.771	3.885	Pucca Road		60		6.6
1327	265643.014	2588633.663	3.962	Pucca Road		60		6.6
1328	265645.43	2588628.459	.3.958	Pucca Road		60		6.6
1329	258235.995	2591312.381	3.845	Pucca Road		60		6.6
1330	258234.872	2591315.335	3.895	Pucca Road		60		6.6
1331	258420.685	2591541.161	3.954	Pucca Road		60		6.6
1332	258423.606	2591543.145	3.912	Pucca Road		60		6.6
1333	259575.549	2591662.129	3.795	Pucca Road		60		6.6
1334	259571.982	2591661.994	3.786	Pucca Road		60		6.6
1335	260518.397	2591360.644	3.954	Pucca Road		60		6.6
1336	260521.351	2591356.98	3.992	Pucca Road		60		6.6
1337	261614.141	2590983.401	3.895	Pucca Road		60		6.6
1338	261617.27	2590982.32	3.912	Pucca Road		60		6.6
1339	262370.499	2590796.326	3.913	Pucca Road		60		6.6
1340	262373.659	2590795.546	3.952	Pucca Road		60		6.6
1341	263331.743	2590212.168	3.758	Pucca Road		60		6.6
1342	263326.289	2590214.421	3.821	Pucca Road		60		6.6
1343	263651.601	2590080.021	3.912	Pucca Road		60		6.6
1344	263648.512	2590081.298	3.932	Pucca Road		60		6.6
1345	264376.623	2589292.228	3.985	Pucca Road		60		6.6
1346	264379.439	2589292.521	3.976	Pucca Road		60		6.6
1347	280482.511	2575065.114	5.879	RCC Road		60		6.6
1348	280493.383	2575063.044	5.877	RCC Road		60		6.6
1349	278259.182	2577186.819	5.724	Tinshed	5	6		6.6
1350	278261.814	2577186.269	5.724	Tinshed	5	6		6.6
1351	278248.298	2577189.093	5.724	Tinshed	5	6		6.6
1352	278243.32	2577190.134	5.724	Tinshed	5	6		6.6
1353	273400.671	2579136.224	4.256	Tinshed	5	6		6.6
1354	273399.21	2579136.478	4.256	Tinshed	5	6		6.6
1355	272847.193	2580090.036	5.321	Tinshed	5	6		6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1356	272848.788	2580086.574	5.321	Tinshed	5	6		6.6
1357	272856.928	2580068.903	5.321	Tinshed	5	6		6.6
1358	272857.283	2580068.132	5.321	Tinshed	5	6		6.6
1359	272355.893	2581156.529	5.798	Tinshed	5	6		6.6
1360	272354.304	2581159.98	5.798	Tinshed	5	6		6.6
1361	274350.71	2578762.825	4.125	Tree	12.25			6.6
1362	280549.129	2575052.429	4.212	Tree	14.26			6.6
1363	280568.222	2575048.794	4.251	Tree	15.35			6.6
1364	266241.331	2587737.981	3.654	Tree	12.25			6.6
1365	266242.448	2587737.353	3.562	Tree	13.35			6.6
1366	266247.582	2587734.467	3.521	Tree	13.36			6.6
1367	261953.276	2590899.35	3.854	Tree	14.25			6.6
1368	262002.36	2590887.23	3.812	Tree	13.36			6.6
1369	264293.853	2589283.605	3.854	Tree	15.24			6.6
1370	264373.952	2589291.949	3.754	Tree	12.25			6.6
1371	274340.718	2578770.267	4.125	Tree	14.26			6.6
1372	272468.564	2582000.814	5.854	Tree	15.35			6.6
1373	272469.693	2582004.05	5.865	Tree	12.25			6.6
1374	273345.295	2579145.83	4.523	Tree	13.35			6.6
1375	273362.183	2579142.9	4.574	Tree	13.36			6.6
1376	273302.303	2579153.296	4.754	Tree	14.25			6.6
1377	273305.258	2579152.774	4.765	Tree	13.36			6.6
1378	273269.109	2579173.881	5.201	Tree	15.24			6.6
1379	273270.675	2579170.759	5.254	Tree	12.25			6.6
1380	269922.008	2584982.068	4.795	Tree	14.26			6.6
1381	269917.426	2584984.668	4.754	Tree	15.35			6.6
1382	258549.353	2591607.723	3.521	Tree	12.25			6.6
1383	258796.582	2591707.355	3.958	Tree	13.35			6.6
1384	258897.138	2591747.519	3.912	Tree	13.36			6.6
1385	266571.089	2587552.587	3.998	Tree	14.25			6.6
1386	266751.899	2587426.146	3.542	Tree	13.36			6.6
1387	269850.6	2585022.588	4.754	Tree	15.24			6.6
1388	270161.884	2584845.954	5.521	Tree	12.25			6.6
1389	271004.773	2584341.169	4.923	Tree	14.26			6.6
1390	271134.216	2583751.084	4.878	Tree	15.35			6.6
1391	271578.104	2583478.048	4.255	Tree	12.25			6.6
1392	271620.289	2583457.585	4.266	Tree	13.35			6.6
1393	272129.074	2582730.656	4.985	Tree	13.36			6.6
1394	272481.247	2582037.157	4.574	Tree	14.25			6.6
1395	272844.237	2580096.453	5.384	Tree	13.36			6.6
1396	273254.445	2579205.989	4.547	Tree	15.24			6.6
1397	273487.294	2579121.199	4.574	Tree	12.25			6.6
1398	273612.352	2579099.508	4.354	Tree	14.26			6.6
1399	273941.796	2579042.364	4.352	Tree	15.35			6.6
1400	275505.193	2578278.242	4.352	Tree	12.25			6.6
1401	278100.992	2577219.875	4.352	Tree	13.35			6.6
1402	278967.635	2576371.977	4.352	Tree	13.36			6.6
1403	279411.335	2575395.343	4.362	Tree	14.25			6.6
1404	279667.102	2575187.931	4.525	Tree	13.36			6.6
1405	280057.504	2575081.466	4.365	Tree	15.24			6.6
1406	280189.22	2575086.097	4.361	Tree	12.25			6.6
1407	280221.423	2575087.229	4.421	Tree	14.26			6.6
1408	280508.338	2575060.196	4.125	Tree	15.35			6.6
1409	281043.229	2574958.346	4.125	Tree	12.25			6.6
1410	273569.385	2579106.96	4.254	Tree	13.35			6.6
1411	280528.339	2575056.388	4.162	Tree	13.36			6.6
1412	275643.098	2578398.157	4.241	Tree	14.25			6.6
1413	272361.042	2581145.353	5.741	Tree	13.36			6.6
1414	272310.97	2581254.047	5.241	Tree	15.24			6.6
1415	272320.709	2581232.905	5.214	Tree	12.25			6.6
1416	272470.485	2582006.319	4.754	Tree	14.26			6.6
1417	281245.262	2574782.856	4.254	Tree	15.35			6.6
1418	281261.44	2574751.856	4.325	Tree	12.25			6.6
1419	272330.182	2581212.342	5.214	Tree	13.35			6.6
1420	279485.223	2575261.013	4.352	Tree	13.36			6.6
1421	279238.739	2575845.243	4.251	Tree	14.25			6.6
1422	279206.335	2575929.708	4.124	Tree	13.36			6.6
1423	271129.001	2583774.859	4.895	Tree	15.24			6.6
1424	270995.397	2584383.913	4.854	Tree	12.25			6.6
1425	270165.574	2584843.86	5.547	Tree	14.26			6.6
1426	266734.126	2587452.556	3.621	Tree	15.35			6.6
1427	266567.375	2587554.675	3.987	Tree	12.25			6.6
1428	258527.195	2591598.816	3.478	Tree	13.35			6.6
1429	262804.352	2590447.987	3.452	Tree	13.36			6.6
1430	263002.632	2590348.138	3.624	Tree	14.25			6.6
1431	263044.661	2590330.774	3.632	Tree	13.36			6.6
1432	263185.999	2590272.381	3.574	Tree	15.24			6.6
1433	263212.051	2590261.618	3.595	Tree	12.25			6.6
1434	264201.942	2589327.381	3.874	Tree	14.26			6.6
1435	264215.129	2589318.004	3.825	Tree	15.35			6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1436	264530.637	2589266.311	3.754	Tree	12.25			6.6
1437	264575.164	2589243.078	3.765	Tree	13.35			6.6
1438	262821.198	2590430.988	3.521	Tree	13.36			6.6
1439	272116.999	2582749.153	4.865	Tree	14.25			6.6
1440	272923.986	2579923.338	5.245	Tree	13.36			6.6
1441	275499.128	2578272.968	4.421	Tree	15.24			6.6
1442	275777.392	2578514.931	4.574	Tree	12.25			6.6
1443	276422.661	2578538.452	4.574	Tree	14.26			6.6
1444	278139.5	2577211.828	4.352	Tree	15.35			6.6
1445	278207.964	2577197.522	4.352	Tree	12.25			6.6
1446	278303.141	2577177.633	4.352	Tree	13.35			6.6
1447	279408.493	2575402.751	4.256	Tree	13.36			6.6
1448	280239.165	2575087.853	4.421	Tree	14.25			6.6
1449	280437.075	2575073.766	4.695	Tree	13.36			6.6
1450	280425.05	2575076.056	4.658	Tree	15.24			6.6
1451	278967.047	2576372.849	4.352	Tree	12.25			6.6
1452	281271.141	2574733.071	4.912	Tree	14.26			6.6
1453	281270.098	2574735.078	4.895	Tree	15.35			6.6
1454	281242.76	2574787.474	4.812	Tree	12.25			6.6
1455	281242.163	2574790.471	4.854	Tree	13.35			6.6
1456	280314.051	2575090.486	5.965	Tree	13.36			6.6
1457	280317.053	2575090.591	5.963	Tree	14.25			6.6
1458	279210.524	2575918.788	5.896	Tree	13.36			6.6
1459	277629.463	2577686.296	5.785	Tree	15.24			6.6
1460	277626.644	2577689.89	5.787	Tree	12.25			6.6
1461	276730.678	2578532.275	5.89	Tree	14.26			6.6
1462	276732.684	2578532.175	5.892	Tree	15.35			6.6
1463	276491.088	2578536.987	5.963	Tree	12.25			6.6
1464	276494.532	2578536.919	5.96	Tree	13.35			6.6
1465	276049.904	2578545.663	5.874	Tree	13.36			6.6
1466	276051.923	2578545.624	5.872	Tree	14.25			6.6
1467	274429.497	2578704.139	4.574	Tree	13.36			6.6
1468	274431.796	2578702.426	4.562	Tree	15.24			6.6
1469	273565.299	2579107.669	5.876	Tree	12.25			6.6
1470	273568.224	2579107.162	5.878	Tree	14.26			6.6
1471	277821.232	2577441.854	5.782	Tree	15.35			6.6
1472	277819.772	2577443.714	5.785	Tree	12.25			6.6
1473	272444.973	2581933.218	5.795	Tree	13.35			6.6
1474	272446.991	2581939	5.754	Tree	13.36			6.6
1475	279211.861	2575915.303	5.898	Tree	14.25			6.6
1476	271052.8	2584122.232	5.621	Tree	13.36			6.6
1477	271053.444	2584119.298	5.675	Tree	15.24			6.6
1478	269993.527	2584941.486	5.024	Tree	12.25			6.6
1479	269990.431	2584943.243	5.045	Tree	14.26			6.6
1480	269351.04	2585610.098	4.862	Tree	15.35			6.6
1481	269349.546	2585613.05	4.854	Tree	12.25			6.6
1482	273778.345	2579070.715	4.385	Tree	13.35			6.6
1483	273769.312	2579072.282	4.421	Tree	13.36			6.6
1484	280473.155	2575066.711	5.365	Tree	14.25			6.6
1485	280476.474	2575066.264	5.852	Tree	13.36			6.6
1486	281266.918	2574741.195	4.721	Tree	15.24			6.6
1487	281264.013	2574746.784	4.854	Tree	12.25			6.6
1488	280655.303	2575032.212	5.887	Tree	14.26			6.6
1489	280658.787	2575031.549	5.878	Tree	15.35			6.6
1490	279581.642	2575222.271	5.966	Tree	12.25			6.6
1491	279585.252	2575220.82	5.968	Tree	13.35			6.6
1492	278266.405	2577185.31	5.825	Tree	13.36			6.6
1493	278269.653	2577184.631	5.878	Tree	14.25			6.6
1494	275645.509	2578400.253	5.124	Tree	13.36			6.6
1495	275648.686	2578403.015	5.152	Tree	15.24			6.6
1496	272361.822	2581143.659	6.125	Tree	12.25			6.6
1497	272363.195	2581140.679	6.124	Tree	14.26			6.6
1498	271566.652	2583483.603	5.876	Tree	15.35			6.6
1499	271573.748	2583480.161	5.874	Tree	12.25			6.6
1500	272223.878	2582585.429	6.124	Tree	13.35			6.6
1501	272226.314	2582581.697	6.121	Tree	13.36			6.6
1502	272895.989	2579984.111	6.352	Tree	14.25			6.6
1503	272894.55	2579987.236	6.321	Tree	13.36			6.6
1504	271129.174	2583774.07	5.875	Tree	15.24			6.6
1505	271129.847	2583771.004	5.687	Tree	12.25			6.6
1506	270994.784	2584386.709	5.912	Tree	14.26			6.6
1507	270993.67	2584391.784	5.874	Tree	15.35			6.6
1508	268786.4	2586171.148	5.124	Tree	12.25			6.6
1509	268784.092	2586172.697	5.142	Tree	13.35			6.6
1510	270399.432	2584820.292	5.995	Tree	13.36			6.6
1511	270402.437	2584820.386	5.985	Tree	14.25			6.6
1512	269464.839	2585385.28	5.121	Tree	13.36			6.6
1513	269463.267	2585388.386	5.132	Tree	15.24			6.6
1514	266924.557	2587169.586	4.125	Tree	12.25			6.6
1515	266923.092	2587171.762	4.152	Tree	14.26			6.6

SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1516	266574.477	2587550.682	4.265	Tree	15.35			6.6
1517	266577.991	2587548.706	4.125	Tree	12.25			6.6
1518	265848.882	2588190.201	3.865	Tree	13.35			6.6
1519	265847.225	2588193.771	3.885	Tree	13.36			6.6
1520	265643.014	2588633.663	3.962	Tree	14.25			6.6
1521	265645.43	2588628.459	.3.958	Tree	13.36			6.6
1522	258235.995	2591312.381	3.845	Tree	15.24			6.6
1523	258234.872	2591315.335	3.895	Tree	12.25			6.6
1524	258420.685	2591541.161	3.954	Tree	14.26			6.6
1525	258423.606	2591543.145	3.912	Tree	15.35			6.6
1526	259575.549	2591662.129	3.795	Tree	12.25			6.6
1527	259571.982	2591661.994	3.786	Tree	13.35			6.6
1528	260518.397	2591360.644	3.954	Tree	13.36			6.6
1529	260521.351	2591356.98	3.992	Tree	14.25			6.6
1530	261614.141	2590983.401	3.895	Tree	13.36			6.6
1531	261617.27	2590982.32	3.912	Tree	15.24			6.6
1532	262370.499	2590796.326	3.913	Tree	12.25			6.6
1533	262373.659	2590795.546	3.952	Tree	14.26			6.6
1534	263331.743	2590212.168	3.758	Tree	13.36			6.6
1535	263326.289	2590214.421	3.821	Tree	14.25			6.6
1536	263651.601	2590080.021	3.912	Tree	13.36			6.6
1537	263648.512	2590081.298	3.932	Tree	15.24			6.6
1538	264376.623	2589292.228	3.985	Tree	12.25			6.6
1539	264379.439	2589292.521	3.976	Tree	14.26			6.6
1540	280482.511	2575065.114	5.879	Tree	14.36			6.6
1541	280493.383	2575063.044	5.877	Tree	14.36			6.6

LILO of Chowmuhani- Ramganj 132kV Double Circuit Transmission Line.								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1	302099.783	2550118.566	4.132	AP No - 01		101	58°50'07"LT	
2	302069.573	2550181.711	4.251	AP No - 02		101	62°19'46"LT	
3	302139.526	2550179.142	4.125	AP No - 03		101	21°09'24"LT	
4	303328.772	2551040.932	4.152	TT		101		
5	303369.624	2551070.535	4251	Gantry		101		
6	302099.783	2550118.566	4.132	RL		200		
7	302127.211	2550160.371	4.102	RL		200		
8	302161.834	2550195.308	4.162	RL		200		
9	302202.321	2550224.647	4.251	RL		200		
10	302242.809	2550253.986	4.125	RL		200		
11	302283.296	2550283.326	4.065	RL		200		
12	302323.783	2550312.665	3.684	RL		200		
13	302404.757	2550371.343	3.764	RL		200		
14	302445.245	2550400.682	3.687	RL		200		
15	302485.732	2550430.021	3.621	RL		200		
16	302526.219	2550459.36	3.587	RL		200		
17	302566.706	2550488.7	3.621	RL		200		
18	302607.193	2550518.039	3.584	RL		200		
19	302647.681	2550547.378	3.521	RL		200		
20	302688.168	2550576.717	3.501	RL		200		
21	302728.655	2550606.056	3.521	RL		200		
22	302769.142	2550635.395	3.584	RL		200		
23	302809.63	2550664.734	3.621	RL		200		
24	302850.117	2550694.073	3.541	RL		200		
25	302890.604	2550723.413	3.451	RL		200		
26	302971.578	2550782.091	3.485	RL		200		
27	303012.066	2550811.43	3.595	RL		200		
28	303052.553	2550840.769	3.652	RL		200		
29	303093.04	2550870.108	3.721	RL		200		
30	303133.527	2550899.447	3.763	RL		200		
31	303174.015	2550928.787	3.854	RL		200		
32	303214.502	2550958.126	3.895	RL		200		
33	303254.989	2550987.465	3.932	RL		200		
34	303335.963	2551046.143	4.12	RL		200		
35	302107.823	2550180.307	4.125	RL		200		
36	302069.573	2550181.711	4.251	RL		200		
37	302344.53	2550327.699	3.852	RL		200		
38	303021.588	2550818.33	3.595	RL		200		
39	303369.624	2551070.535	4.251	RL		200		
40	303304.707	2551023.493	4.025	11 kV Line Ht.	8.58	11		
41	302949.712	2550766.245	3.402	11 kV Line Ht.	9.256	11		
42	302359.507	2550338.552	3.952	Canal		75		
43	302387.9	2550359.127	3.921	Canal		75		
44	302382.613	2550355.296	1.62	Canal		75		
45	302376.553	2550350.904	-1.895	Canal		75		
46	302371.632	2550347.339	-1.958	Canal		75		
47	302365.42	2550342.837	1.652	Canal		75		
48	302356.638	2550336.473	5.132	Earthen Road		65		
49	302353.448	2550334.162	5.1254	Earthen Road		65		
50	303016.276	2550814.481	4.932	Earthen Road		65		
51	303018.164	2550815.849	4.912	Earthen Road		65		

LILO Shahjibazar - Brahmanbaria 132kV D/C TL. at Madhabpur Sub-station .								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1	328011.4144	2669305.1030	4.532	AP No - 01		101	42°23'53"LT	
2	327969.303	2669244.4307	4.532	AP No - 02		101	42°24'32"LT	
3	328018.0537	2669255.5375	4.582	AP No - 03		101	58°9'29"LT	
4	328579.7131	2669003.0177	4.784	TT No - 01		101		

LILO of Bogura(S) - Naogaon 132kV line at Dupchanchia.								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1	719182.2218	2753119.609	16.408	AP No - 05		101		
2	719153.8195	2753025.583	16.825	AP No - 04		101		
3	719127.5104	2753093.565	16.42	AP No - 03		101		
4	719093.0705	2753442.384	17.31	AP No - 02		101	44°36'24" RT	
5	718345.7	2754064.07	16.899	AP No - 01		101	24°34'17" LT	
6	718064.4144	2754649.198	16.521	TT No - 01		101	61°11'42" LT	
7	718099.1576	2754697.871	16.82	Gantry		101		
8	718099.158	2754697.871	16.82	RL		200		
9	719184.427	2753366.391	17.325	RL		200		
10	719107.548	2753430.341	16.952	RL		200		
11	719069.109	2753462.316	16.654	RL		200		
12	719030.669	2753494.291	16.574	RL		200		
13	718992.23	2753526.266	16.502	RL		200		
14	718953.79	2753558.241	16.485	RL		200		
15	718915.351	2753590.217	16.578	RL		200		
16	718876.911	2753622.192	16.521	RL		200		
17	718838.472	2753654.167	16.452	RL		200		
18	718800.033	2753686.142	16.402	RL		200		
19	718761.593	2753718.117	16.324	RL		200		
20	718723.154	2753750.092	16.152	RL		200		
21	718684.714	2753782.067	16.032	RL		200		
22	718646.275	2753814.042	16.152	RL		200		
23	718607.835	2753846.018	16.102	RL		200		
24	718569.396	2753877.993	16.125	RL		200		
25	718530.956	2753909.968	16.085	RL		200		
26	718492.517	2753941.943	16.132	RL		200		
27	718454.078	2753973.918	16.156	RL		200		
28	718415.638	2754005.893	16.102	RL		200		
29	718377.199	2754037.868	16.12	RL		200		
30	718341.788	2754072.207	16.025	RL		200		
31	718320.125	2754117.27	16.124	RL		200		
32	718298.462	2754162.334	16.152	RL		200		
33	718276.799	2754207.397	16.021	RL		200		
34	718255.136	2754252.46	15.874	RL		200		
35	718233.473	2754297.524	15.925	RL		200		
36	718211.81	2754342.587	15.998	RL		200		
37	718190.147	2754387.651	16.085	RL		200		
38	718168.484	2754432.714	16.052	RL		200		
39	718146.821	2754477.778	16.241	RL		200		
40	718103.495	2754567.904	16.472	RL		200		
41	718081.832	2754612.968	16.595	RL		200		
42	718070.108	2754657.175	16.624	RL		200		
43	718120.991	2754531.508	16.521	RL		200		
44	718126.827	2754519.369	16.541	RL		200		
45	719242.24	2753318.3	18.102	RL		200		
46	718664.136	2753799.185	16.102	RL		200		
47	719220.311	2753336.541	17.521	Ditch		70		
48	719161.348	2753385.589	17.251	Ditch		70		
49	719229.642	2753328.779	17.574	Ditch		70		
50	719226.542	2753331.358	16.541	Ditch		70		
51	719223.037	2753334.274	16.521	Ditch		70		
52	719213.118	2753342.525	17.521	Ditch		70		
53	719206.544	2753347.993	17.485	Ditch		70		
54	719242.24	2753318.3	18.102	Tower No. - 65		132		
55	719163.511	2753383.789	17.162	Ditch		70		
56	718124.538	2754524.131	17.993	Earthen Road		65		
57	718122.692	2754527.97	17.985	Earthen Road		65		
58	718657.495	2753804.709	17.985	Pucca Road		60		
59	718651.972	2753809.304	17.952	Pucca Road		60		

LILO of Bheramara - Rajbari 132kV Line at Kumarkhali.								
SL No.	Easting	Northing	Elivation (PWD)	Code	Crossing Height	Feature Code	Angle of deviation	Highest flood level
1	726415.3184	2642041.86	10.542	AP No.01		101		
2	726512.4194	2642018.43	10.562	AP No.02		101		
3	726453.1482	2641981.194	10.532	AP No.03		101	16°40'18"LT	
4	726308.4552	2641815.981	10268	TT No - 01		101	29°47'42"LT	
5	726415.318	2642041.86	10.542	RL		200		
6	726512.411	2642018.393	10.562	RL		200		
7	726453.148	2641981.195	10.521	RL		200		
8	726388.838	2641907.764	10.354	RL		200		
9	726308.024	2641813.906	10.268	RL		200		
10	726299.976	2641773.991	10.231	RL		200		

Ashuganj-Brahmanbaria-Shahjibazar 132kV TL

Sl.	Easting	Northing	Tower No
1	325853.55	2663598.248	1
2	303442.785	2659926.479	T-127
3	303477.104	2660024.422	T-126
4	303796.074	2660084.636	T-125
5	304191.309	2660156.551	T-124
6	304565.009	2660226.722	T-123
7	319814.182	2659561.532	T-81
8	319442.748	2659692.271	T-82
9	320136.648	2659742.786	T-80
10	319061.706	2659818.966	T-83
11	320455.258	2659919.144	T-79
12	318692.991	2659946.623	T-84
13	311400.829	2660062.914	T-104
14	312931.999	2660044.98	T-100
15	309425.299	2660095.426	T-109
16	312167.962	2660059.34	T-102
17	312549.277	2660054.335	T-101
18	311797.332	2660064.701	T-103
19	309803.755	2660092.292	T-108
20	309053.675	2660102.778	T-110
21	311002.627	2660077.356	T-105
22	308685.134	2660108.735	T-111
23	313329.881	2660048.973	T-99
24	310193.866	2660090.486	T-107
25	308313.158	2660115.767	T-112
26	313660.32	2660045.692	T-98
27	310579.583	2660087.308	T-106
28	307941.191	2660122.809	T-113
29	314051.45	2660046.205	T-97
30	314406.322	2660046.722	T-96
31	314783.938	2660051.728	T-95
32	307576.698	2660149.233	T-114
33	315502.913	2660047.892	T-93
34	315140.201	2660052.921	T-94
35	315864.024	2660052.807	T-92
36	316257.681	2660050.135	T-91
37	307204.643	2660176.113	T-115
38	316643.907	2660057.472	T-90
39	317025.894	2660055.646	T-89
40	317404.2	2660056.337	T-88
41	317766.927	2660053.591	T-87
42	306834.761	2660203.427	T-116
43	318132.302	2660055.939	T-86
44	318364.27	2660057.377	T-85

Ashuganj-Brahmanbaria-Shahjibazar 132kV TL

Sl.	Easting	Northing	Tower No
45	306467.537	2660230.948	T-117
46	306104.774	2660258.75	T-118
47	304888.273	2660284.862	T-122
48	305736.534	2660286.979	T-119
49	320770.367	2660091.122	T-78
50	305408.402	2660309.554	T-120
51	305142.799	2660332.303	T-121
52	321085.2	2660268.448	T-77
53	321402.349	2660439.715	T-76
54	321714.355	2660612.759	T-75
55	322018.703	2660778.394	T-74
56	322322.371	2660944.731	T-73
57	322641.687	2661127.605	T-72
58	322986.138	2661315.291	T-71
59	323317.618	2661511.01	T-70
60	323675.673	2661718.005	T-69
61	324005.891	2661924.333	T-68
62	324338.11	2662126.201	T-67
63	324689.792	2662332.799	T-66
64	325017.501	2662532.688	T-65
65	325294.981	2662698.683	T-64
66	325463.607	2662979.072	T-63
67	325665.697	2663328.702	T-62
68	325858.58	2663656.249	T-61
69	325860.108	2664025.764	T-60
70	325861.602	2664389.885	T-59
71	325859.159	2664746.323	T-58
72	325860.724	2665056.147	T-57
73	325863.728	2665443.001	T-56
74	325862.624	2665837.26	T-55
75	325861.559	2666214.617	T-54
76	326065.646	2666506.107	T-53
77	326278.151	2666813.204	T-52
78	326487.83	2667115.198	T-51
79	326710.781	2667435.808	T-50
80	326935.868	2667759.053	T-49
81	327146.624	2668057.309	T-48
82	327350.596	2668351.884	T-47
83	327555.84	2668647.277	T-46
84	327771.783	2668960.498	T-45
85	327988.561	2669272.881	T-44
86	328196.902	2669570.913	T-43
87	328397.17	2669866.144	T-42
88	328608.17	2670160.948	T-41

Ashuganj-Brahmanbaria-Shahjibazar 132kV TL

Sl.	Easting	Northing	Tower No
89	333634.945	2680370.057	T-10
90	333848.116	2680644.618	T-9
91	334057.773	2680929.402	T-8
92	328826.945	2670482.599	T-40
93	329033.769	2670781.624	T-39
94	329265.706	2671111.474	T-38
95	329471.021	2671403.079	T-37
96	329681.147	2671706.69	T-36
97	329905.93	2672026.389	T-35
98	330123.213	2672345.251	T-34
99	330331.799	2672639.584	T-33
100	330541.852	2672940.87	T-32
101	330753.326	2673244.446	T-31
102	330980.02	2673571.535	T-30
103	331207.684	2673893.875	T-29
104	331420.636	2674204.486	T-28
105	331616.993	2674487.406	T-27
106	331712.242	2674833.409	T-26
107	331818.816	2675229.199	T-25
108	331920.938	2675610.676	T-24
109	332024.968	2675995.831	T-23
110	332126.602	2676376.351	T-22
111	332222.547	2676736.659	T-21
112	332316.193	2677088.531	T-20
113	332415.22	2677449.856	T-19
114	332510.504	2677801.699	T-18
115	332605.667	2678171.266	T-17
116	332701.275	2678523.738	T-16
117	332790.572	2678844.441	T-15
118	332935.778	2679175.638	T-14
119	333091.695	2679519.826	T-13
120	333238.865	2679841.255	T-12
121	333440.721	2680106.762	T-11
122	334662.625	2681786.61	T-5
123	334866.207	2682091.468	T-4
124	335056.945	2682371.201	T-3
125	335238.767	2682594.895	T-2
126	335405.15	2682796.131	T-1
127	335455.803	2683121.792	TT-1
128	335439.867	2683159.138	1
129	334250.257	2681190.864	T-7
130	334454.739	2681481.805	T-6
131	298389.269	2660352.553	T-15
132	304311.345	2654908.158	T-144

Ashuganj-Brahmanbaria-Shahjibazar 132kV TL

Sl.	Easting	Northing	Tower No
133	304277.985	2655192.158	T-143
134	304254.065	2655440.635	T-142
135	307179.91	2650577.811	T-163
136	307316.279	2650652.546	T-164
137	307013.433	2650665.665	T-162
138	306786.897	2650782.39	T-161
139	307341	2650890.146	TT-2
140	306659.863	2650999.501	T-160
141	304187.502	2656050.584	T-140
142	304152.948	2656368.732	T-139
143	304117.476	2656679.891	T-138
144	304085.313	2656990.174	T-137
145	304051.994	2657306.632	T-136
146	304023.989	2657558.424	T-135
147	303949.13	2657863.101	T-134
148	303879.718	2658141.782	T-133
149	303809.672	2658434.862	T-132
150	303738.316	2658722.61	T-131
151	303687.41	2658969.345	T-130
152	306535.691	2651211.912	T-159
153	306388.333	2651397.852	T-158
154	306227.686	2651596.779	T-157
155	306049.818	2651820.378	T-156
156	305863.891	2652052.828	T-155
157	305922.562	2652322.713	T-154
158	305788.612	2652545.723	T-153
159	305618.393	2652814.033	T-152
160	305453.162	2653079.709	T-151
161	305282.614	2653352.018	T-150
162	305120.99	2653611.037	T-149
163	304952.476	2653880.021	T-148
164	304793.331	2654137.759	T-147
165	304627.262	2654403.005	T-146
166	304468.903	2654657.037	T-145
167	304217.825	2655756.357	T-141
168	299529.381	2659296.768	T-176
169	303607.801	2659288.459	T-129
170	299890.367	2659361.748	T-175
171	300273.74	2659433.768	T-174
172	299197.342	2659459.654	T-176
173	300666.42	2659508.184	T-173
174	301059.635	2659580.464	T-172
175	298822.665	2659647.553	T-178
176	303528.659	2659610.856	T-128

Ashuganj-Brahmanbaria-Shahjibazar 132kV TL

Sl.	Easting	Northing	Tower No
177	301446.594	2659649.552	T-171
178	301840.675	2659725.541	T-170
179	302230.958	2659795.843	T-169
180	302616.116	2659868.853	T-168
181	303011.777	2659940.32	T-167
182	303330.334	2660000.53	T-166
183	298701.549	2659846.292	T-179

CLIENT : **POWERGRID COMPANY BANGLADESH PLC**

PROJECT NAME: **Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.**

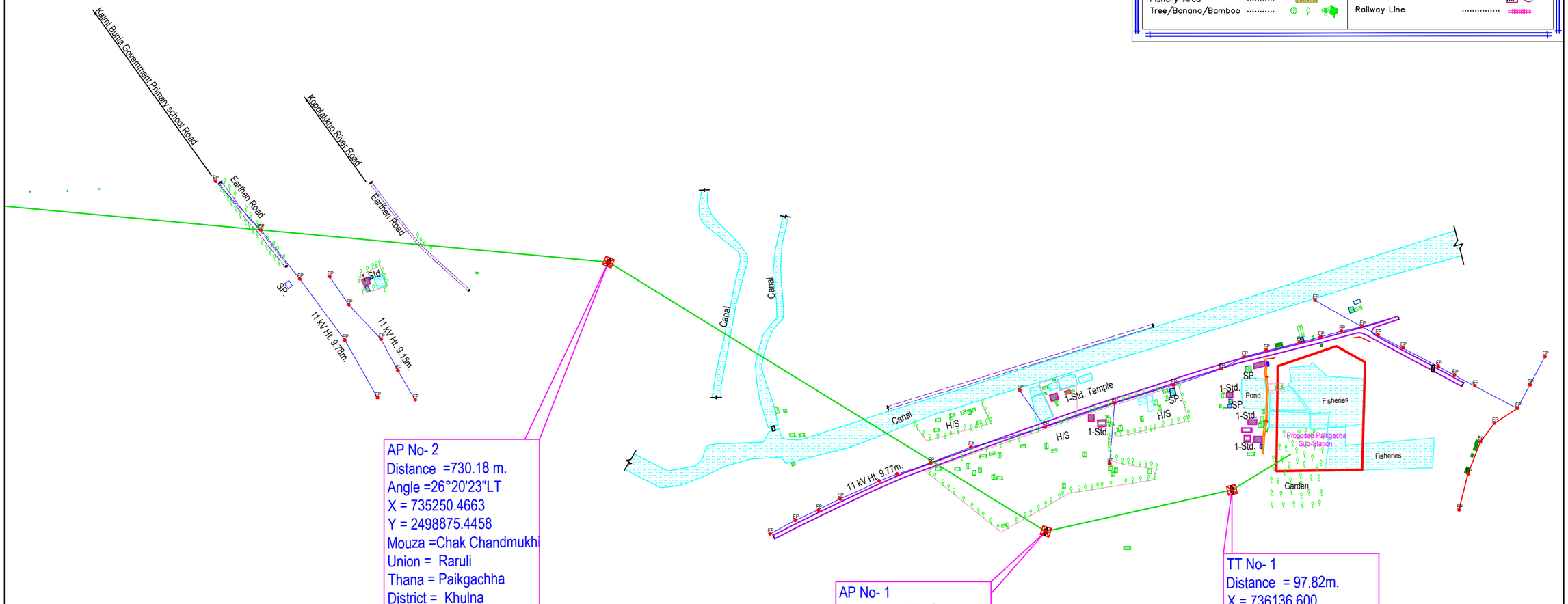
LINE NAME : Proposed Satkhira- Paikgacha 132kV Double Ctrcuit Transmission Line.

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Satkhira-Paikgacha 132kV Double Ctrcuit Transmission Line
Proposed Route Total Length = 29785.473m.

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LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	.....
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	.....
Tree/Banana/Bamboo	.....	Railway Line	.....



AP No- 2
Distance =730.18 m.
Angle =26°20'23"LT
X = 735250.4663
Y = 2498875.4458
Mouza =Chak Chandmukhi
Union = Raruli
Thana = Paikgachha
District = Khulna

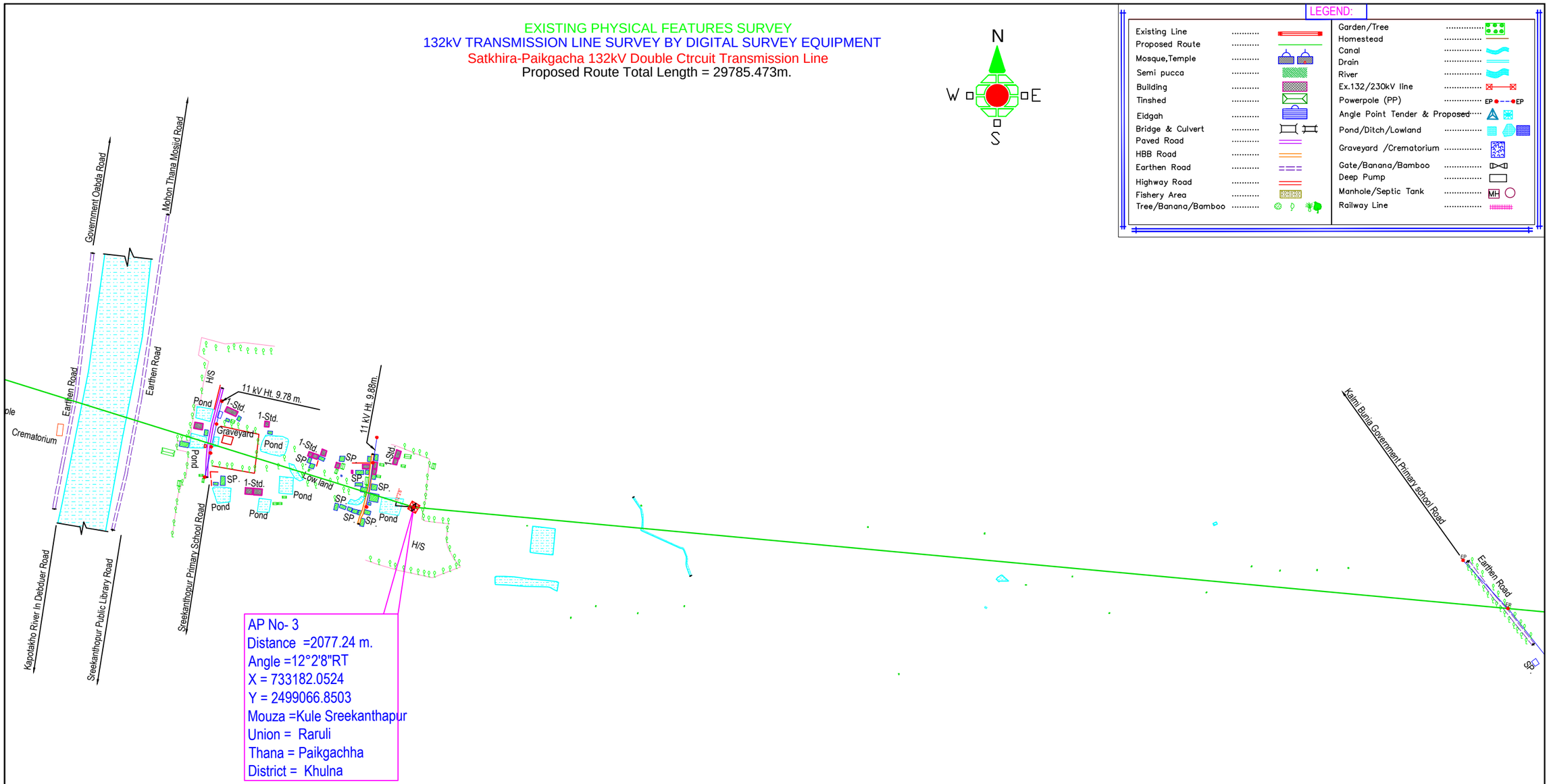
AP No- 1
Distance = 270.87m.
Angle = 44°10'45"RT
X = 735872.2081
Y = 2498492.614
Mouza = Chak Bagura
Union = Laskar
Thana = Paikgachha
District = Khulna

TT No- 1
Distance = 97.82m.
X = 736136.600
Y = 2498551.483
Mouza = Chak Bagura
Union = Laskar
Thana = Paikgachha
District = Khulna

CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Proposed Satkhira- Paikgacha 132kV Double Ctrcuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	1

0 m 60 120 180 240 300
Scale :

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Satkhira-Paikgacha 132kV Double Ctrcuit Transmission Line
Proposed Route Total Length = 29785.473m.



CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Proposed Satkhira- Paikgacha 132kV Double Ctrcuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	1

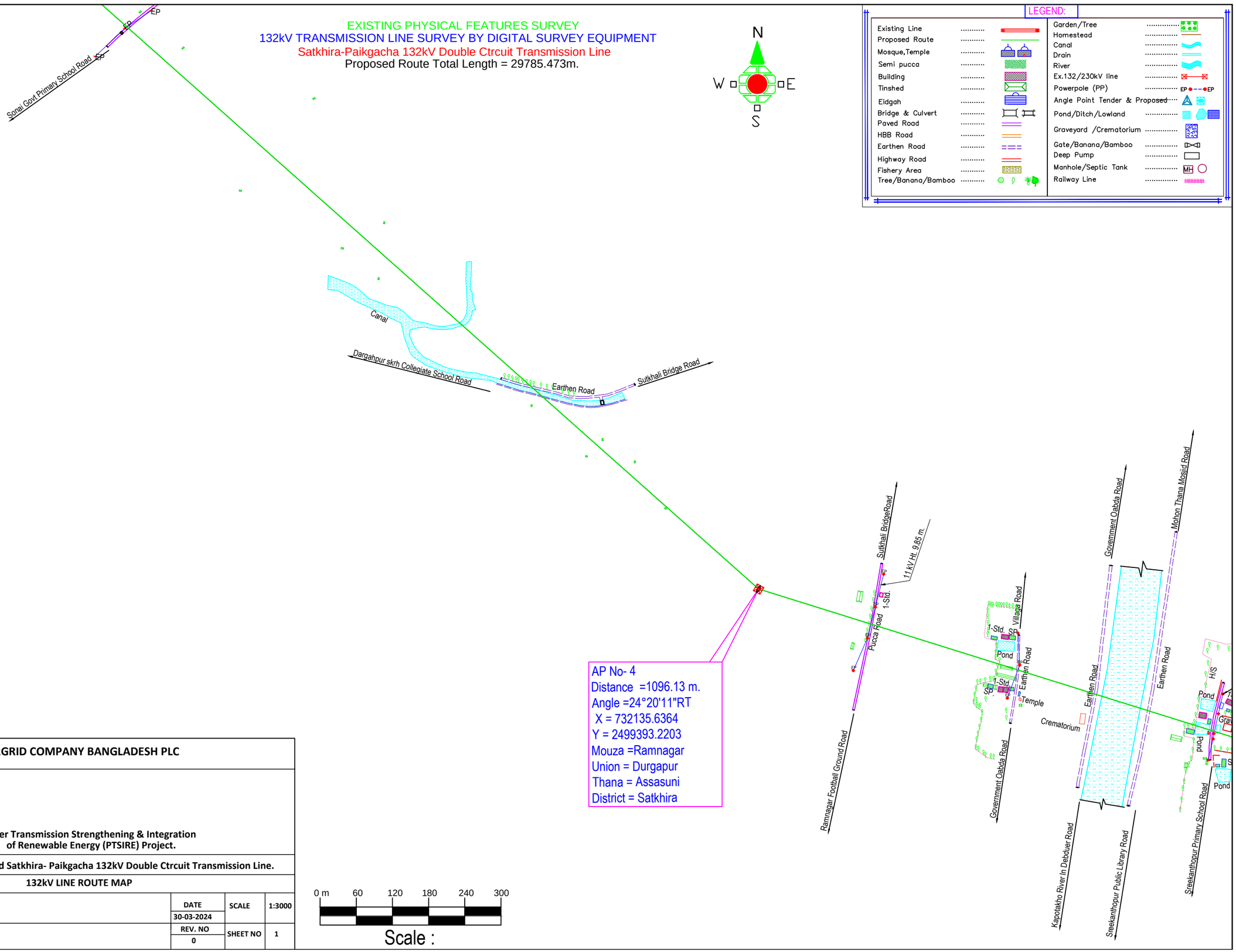
0 m 60 120 180 240 300
Scale :

EXISTING PHYSICAL FEATURES SURVEY

132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT

Satkhira-Paikgacha 132kV Double Ctrcuit Transmission Line

Proposed Route Total Length = 29785.473m.



CLIENT	POWERGRID COMPANY BANGLADESH PLC
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.
LINE NAME	Proposed Satkhira- Paikgacha 132kV Double Ctrcuit Transmission Line.
DESCRIPTION	132kV LINE ROUTE MAP

DATE	30-03-2024	SCALE	1:3000
REV. NO	0	SHEET NO	1

0 m 60 120 180 240 300

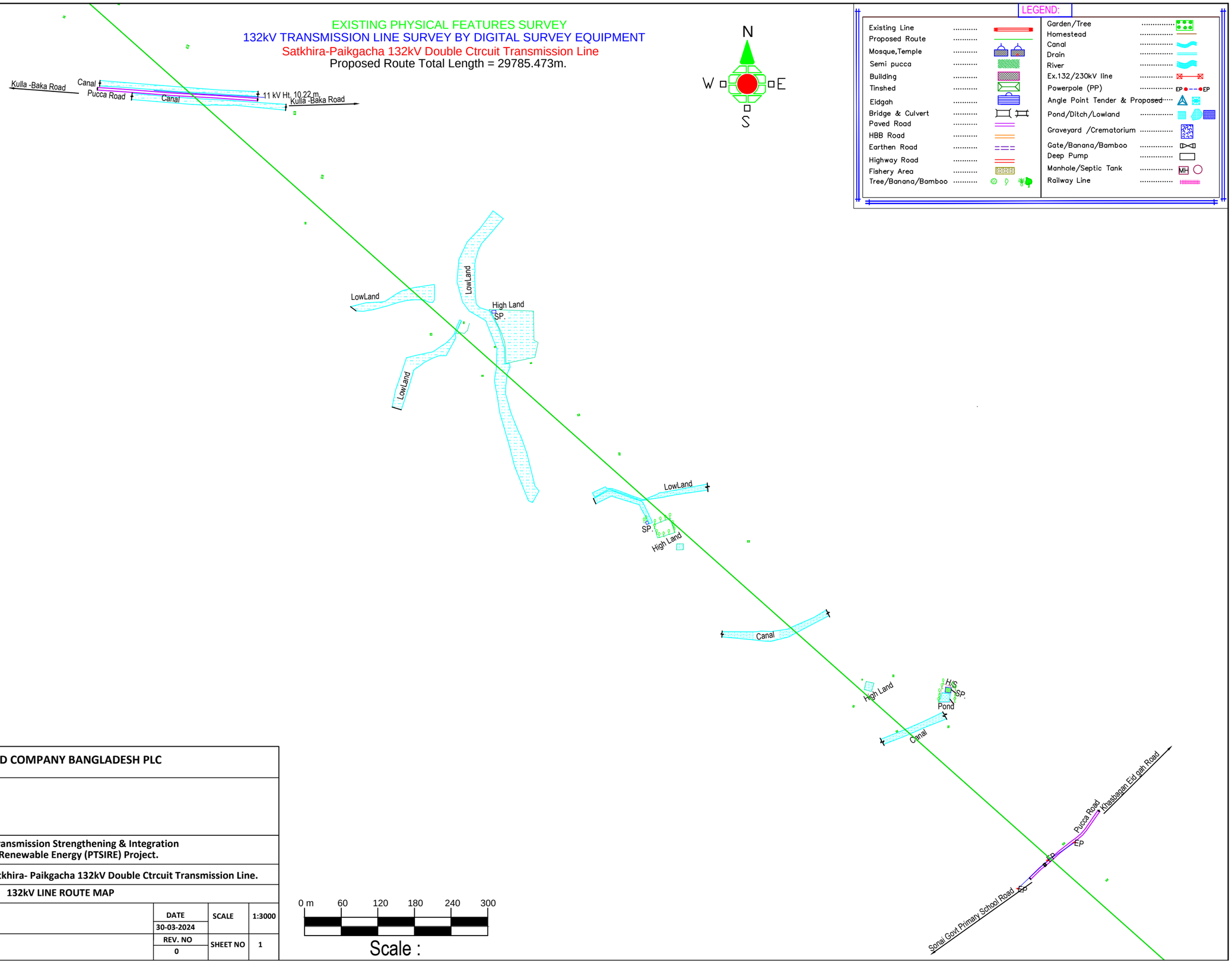
Scale :

EXISTING PHYSICAL FEATURES SURVEY

132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT

Satkhira-Paikgacha 132kV Double Ctrcuit Transmission Line

Proposed Route Total Length = 29785.473m.



LEGEND:

Existing Line		Garden/Tree	
Proposed Route		Homestead	
Mosque,Temple		Canal	
Semi pucca		Drain	
Building		River	
Tinshed		Ex.132/230kV line	
Eidgah		Powerpole (PP)	EP EP
Bridge & Culvert		Angle Point Tender & Proposed	
Paved Road		Pond/Ditch/Lowland	
HBB Road		Graveyard /Crematorium	
Earthen Road		Gate/Banana/Bamboo	
Highway Road		Deep Pump	
Fishery Area		Manhole/Septic Tank	MH
Tree/Banana/Bamboo		Railway Line	

CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Proposed Satkhira- Paikgacha 132kV Double Ctrcuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE	SCALE	1:3000
		30-03-2024		
		REV. NO	SHEET NO	1
		0		

EXISTING PHYSICAL FEATURES SURVEY

132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT

Satkhira-Paikgacha 132kV Double Ctrcuit Transmission Line

Proposed Route Total Length = 29785.473m.

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LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	..... EP EP
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	..... MH
Tree/Banana/Bamboo	.....	Railway Line	.....

AP No- 5
Distance =4402.65 m.
Angle =22°12'49"RT
X = 728846.3630
Y = 2502319.6860
Mouza =Hossainpur
Union = Durgapur
Thana = Assasuni
District = Satkhira

Kulla -Baka Road
Canal
Pucca Road
Canal
11 kV Ht. 10.22 m.
Kulla -Baka Road

0 m 60 120 180 240 300

Scale :

CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Proposed Satkhira- Paikgacha 132kV Double Ctrcuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	1

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Satkhira-Paikgacha 132kV Double Ctrcuit Transmission Line
Proposed Route Total Length = 29785.473m.

N
W E
S

LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	.....
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	.....
Tree/Banana/Bamboo	.....	Railway Line	.....

Kalmi Bunia Government Primary school Road
Khonjakkha River Road
Earthen Road
Earthen Road
SP.
1-Std.
11 KV Ht. 9.78m.
11 KV Ht. 9.15m.
Canal
Canal
Canal
H/S
H/S
H/S
1-Std. Temple
1-Std.
SP.
SP.
1-Std.
SP.
1-Std.
1-Std.
Pond
Fisheries
Proposed Paikgacha Sub-Station
Fisheries
Garden
11 KV Ht. 9.77m.
FP

AP No- 2
Distance =730.18 m.
Angle =26°20'23"LT
X = 735250.4663
Y = 2498875.4458
Mouza =Chak Chandmukhi
Union = Raruli
Thana = Paikgachha
District = Khulna

AP No- 1
Distance = 270.87m.
Angle = 44°10'45"RT
X = 735872.2081
Y = 2498492.614
Mouza = Chak Bagura
Union = Laskar
Thana = Paikgachha
District = Khulna

TT No- 1
Distance = 97.82m.
X = 736136.600
Y = 2498551.483
Mouza = Chak Bagura
Union = Laskar
Thana = Paikgachha
District = Khulna

CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Proposed Satkhira- Paikgacha 132kV Double Ctrcuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE	SCALE	1:3000
		30-03-2024		
		REV. NO	SHEET NO	1
		0		

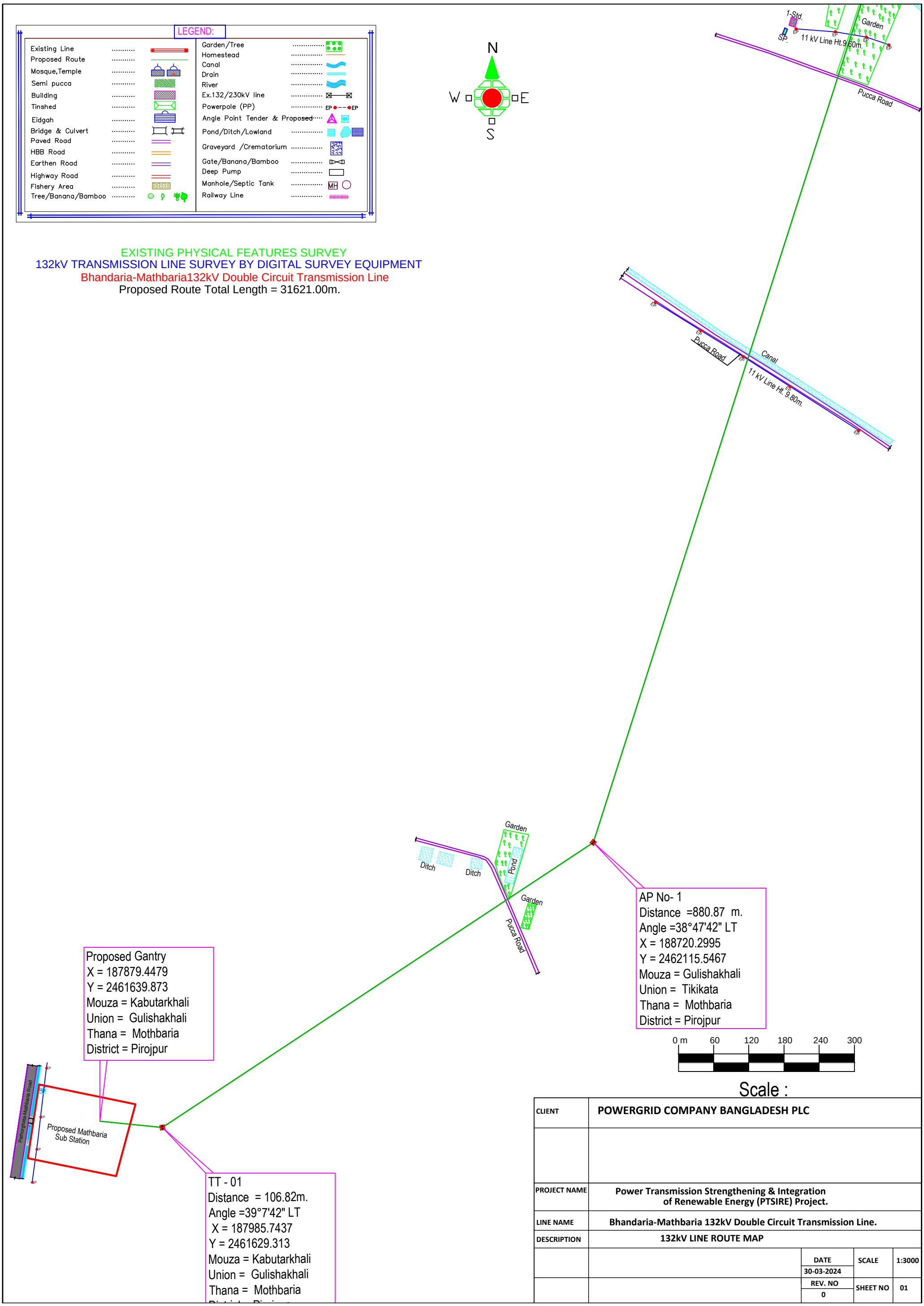
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Scale :

CLIENT : **POWERGRID COMPANY BANGLADESH PLC**

PROJECT NAME: **Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.**

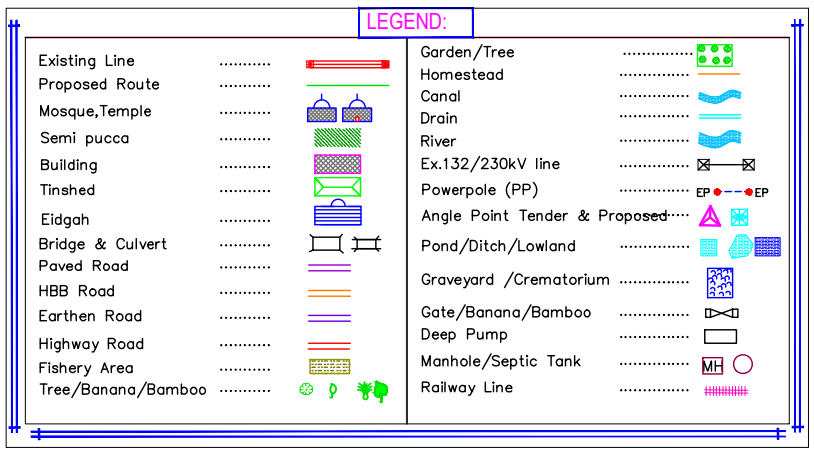
LINE NAME : Bhandaria-Mathbaria132kV Double Circuit Transmission Line

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.

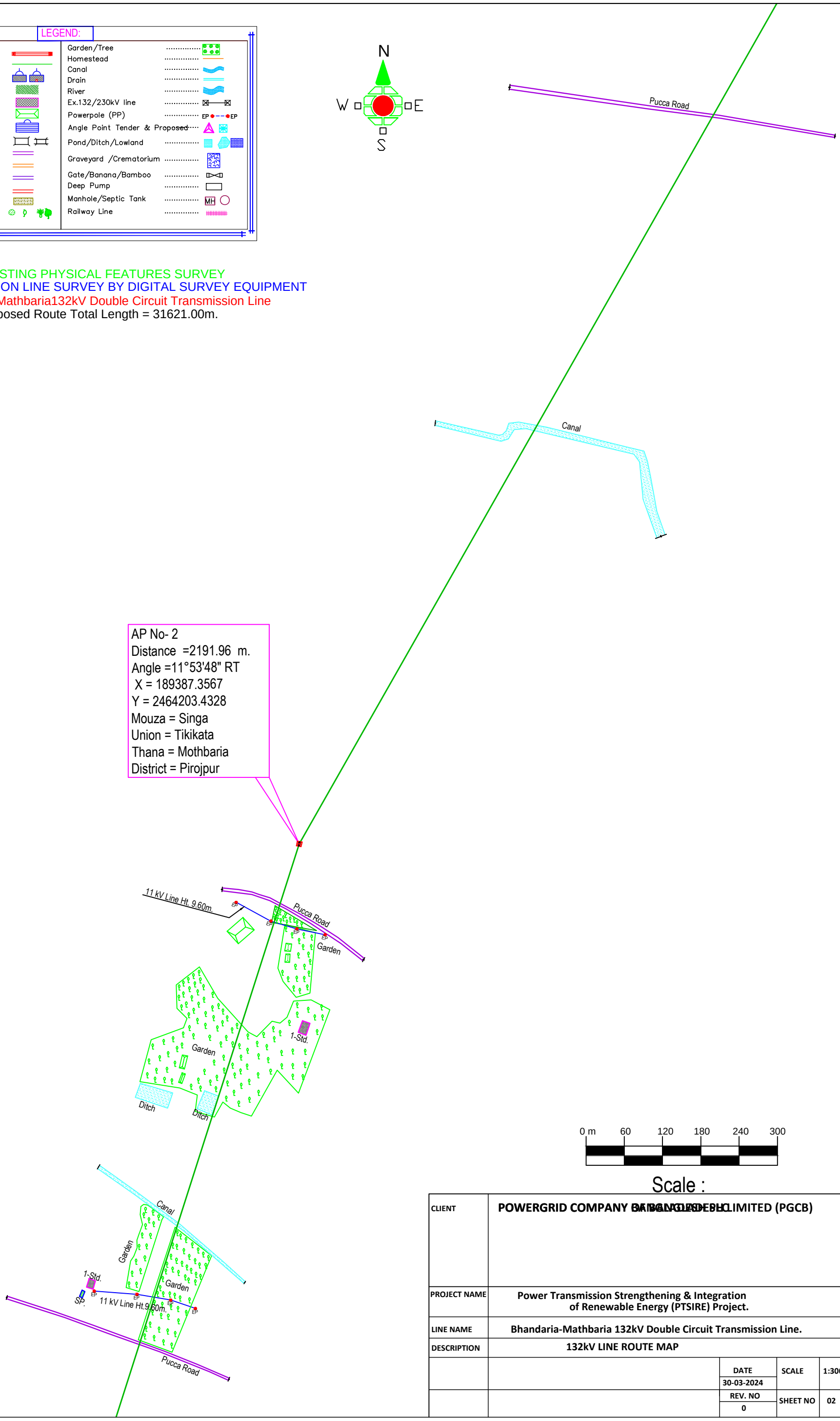


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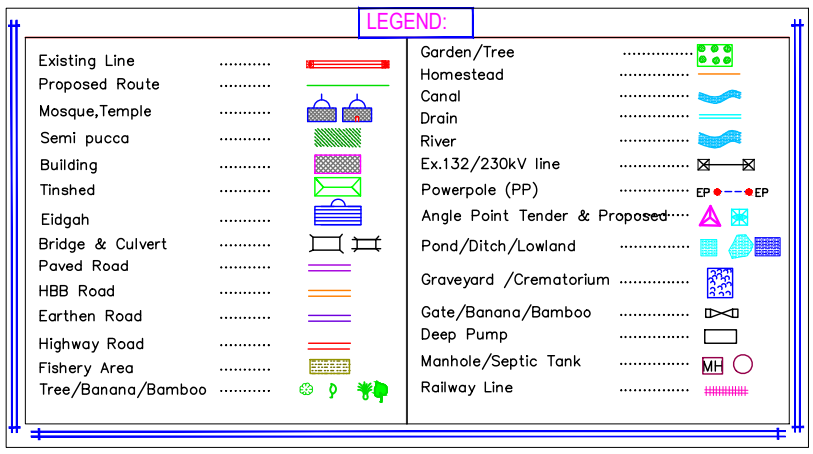
CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	01



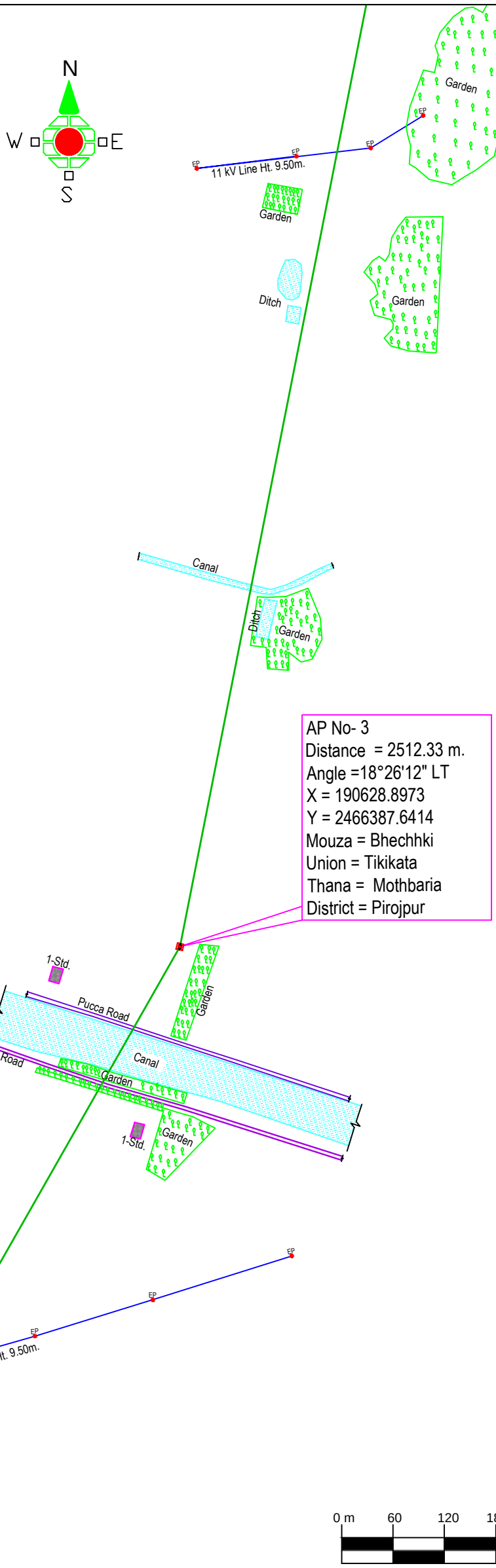
EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.



CLIENT	POWERGRID COMPANY OF BANGLADESH LIMITED (PGCB)			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	02

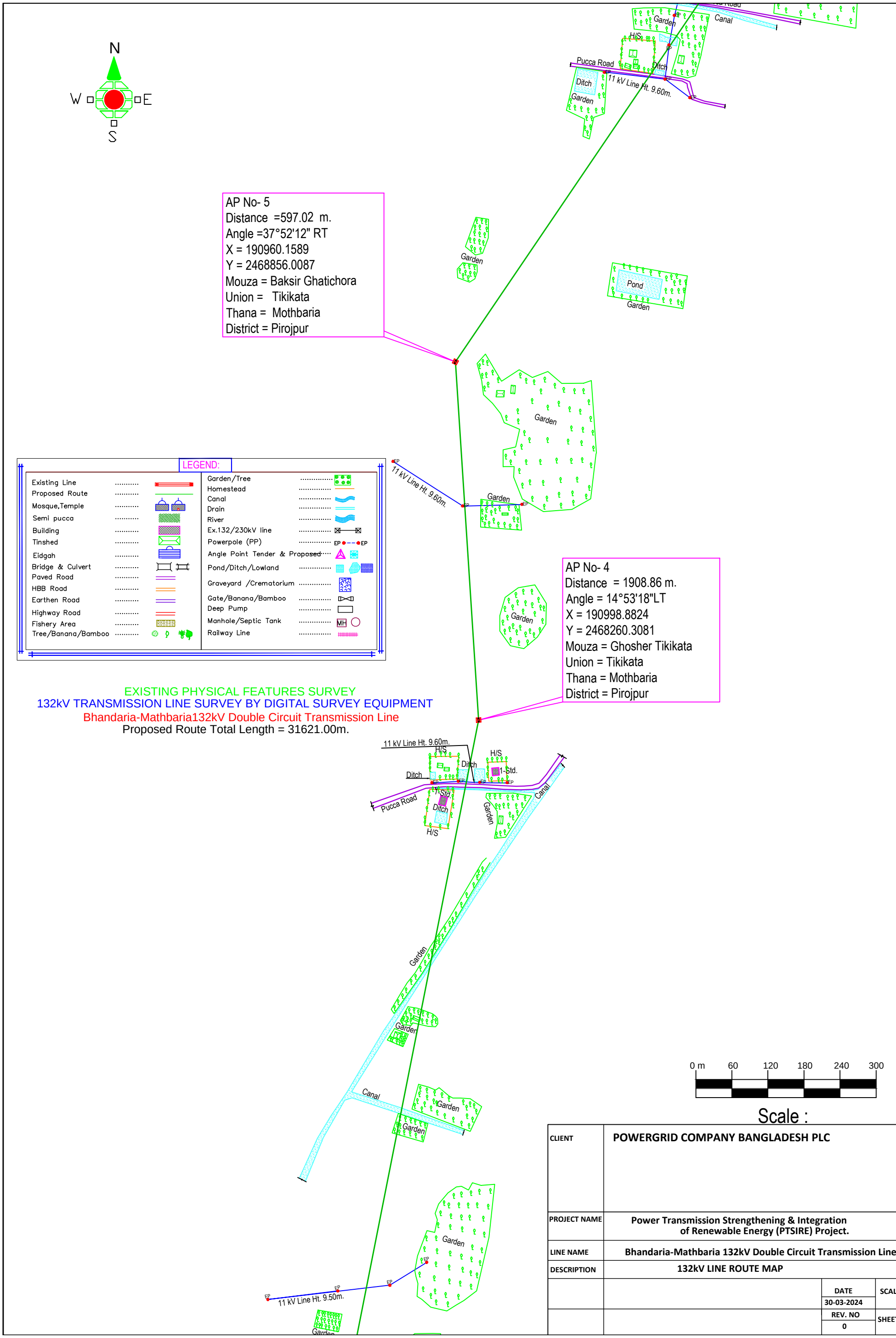


EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.



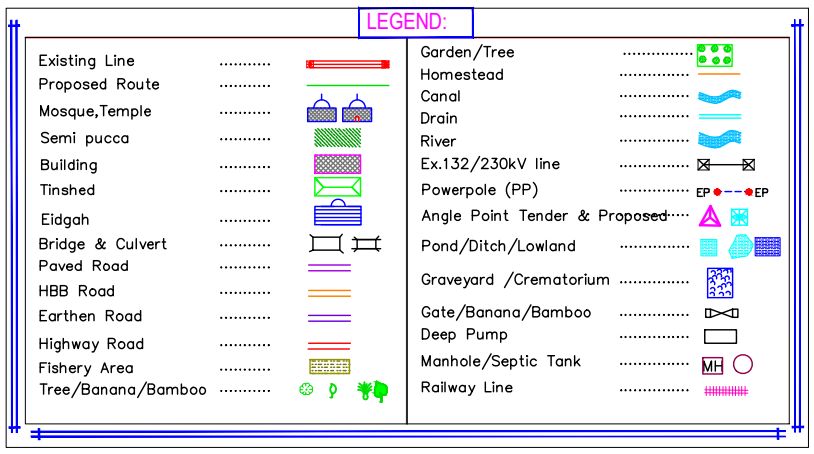
Scale :

CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	03

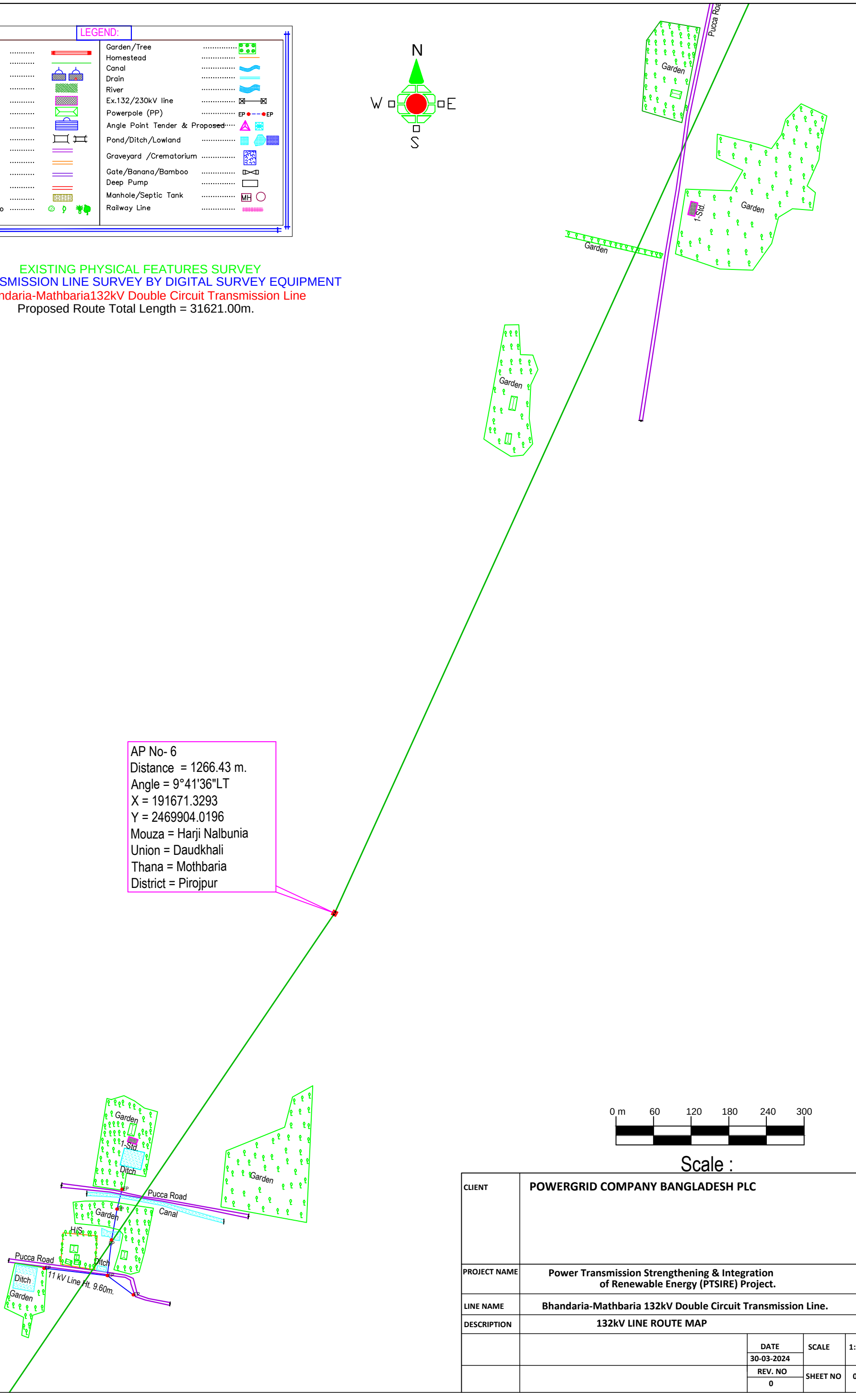


EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.

CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	04

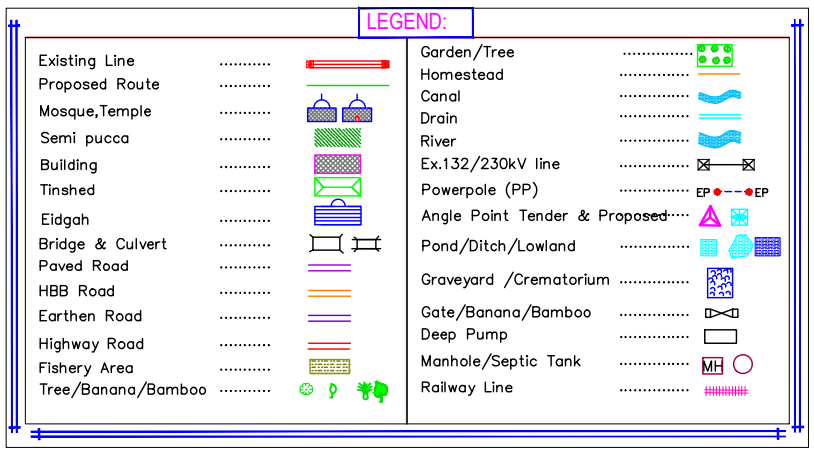


EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.

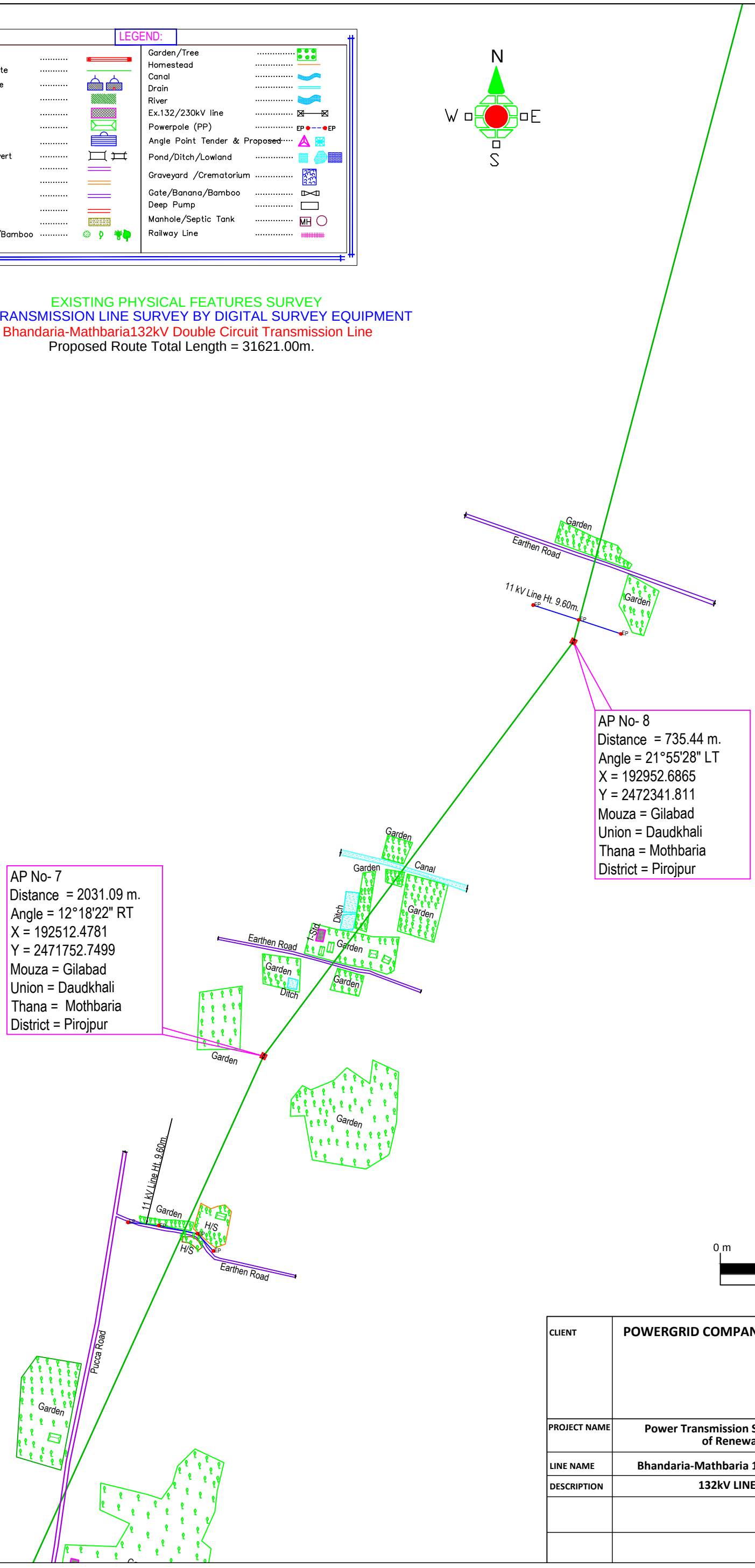


Scale :

CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	05



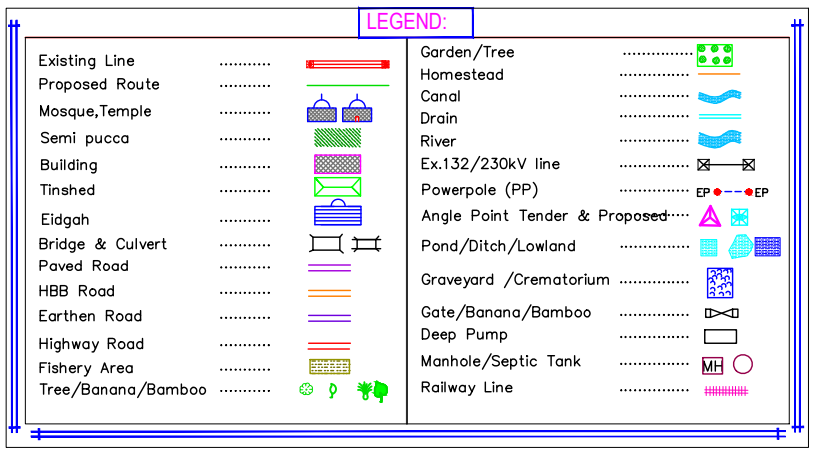
EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.



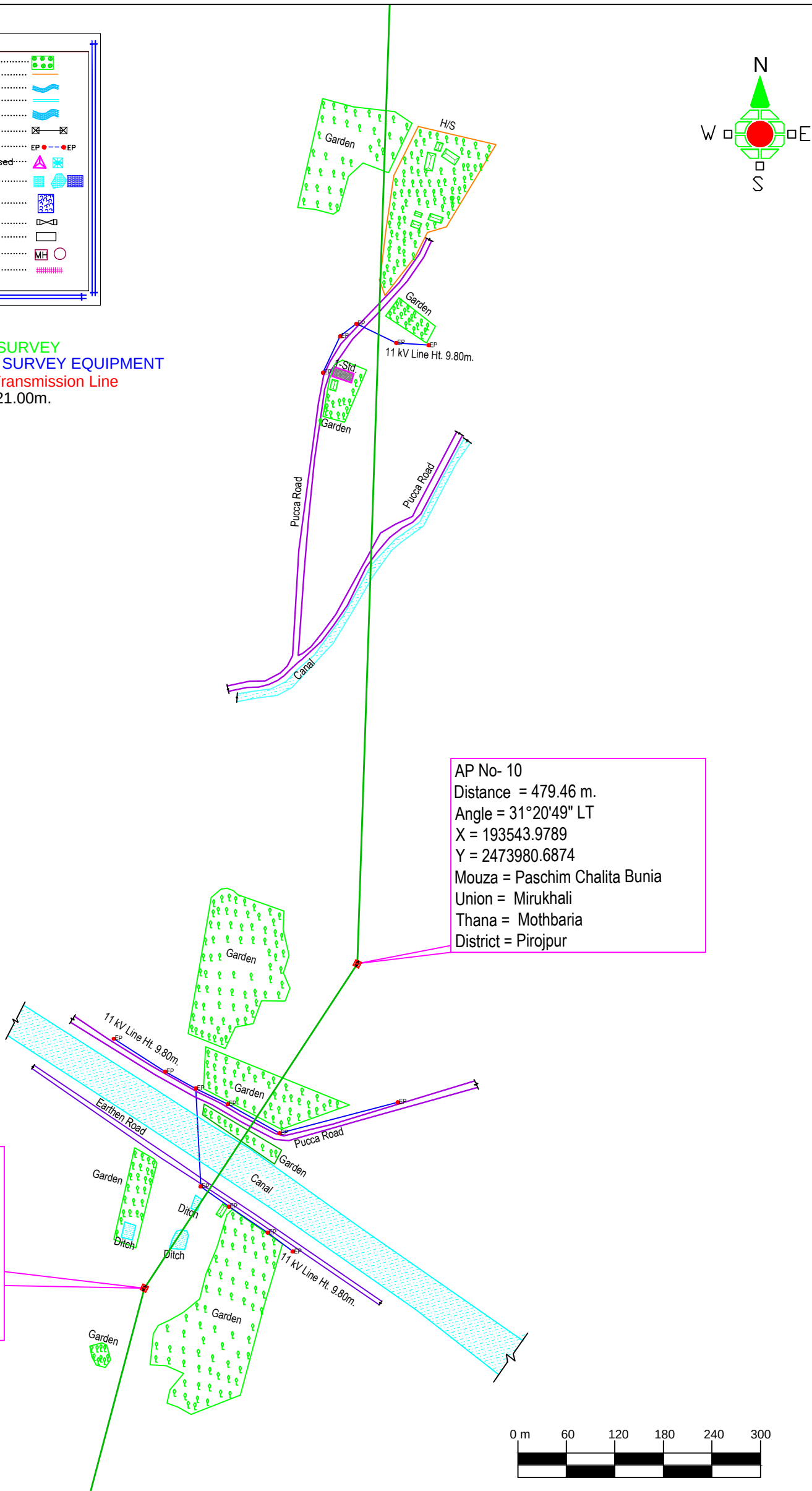
0 m 60 120 180 240 300

Scale :

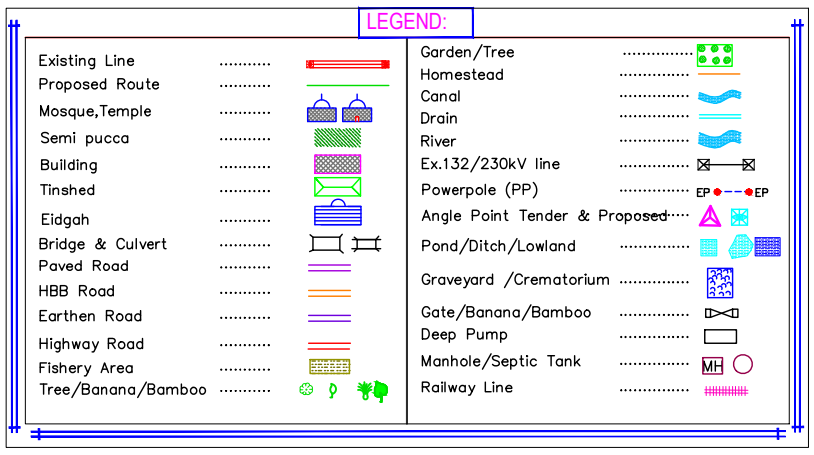
CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	06



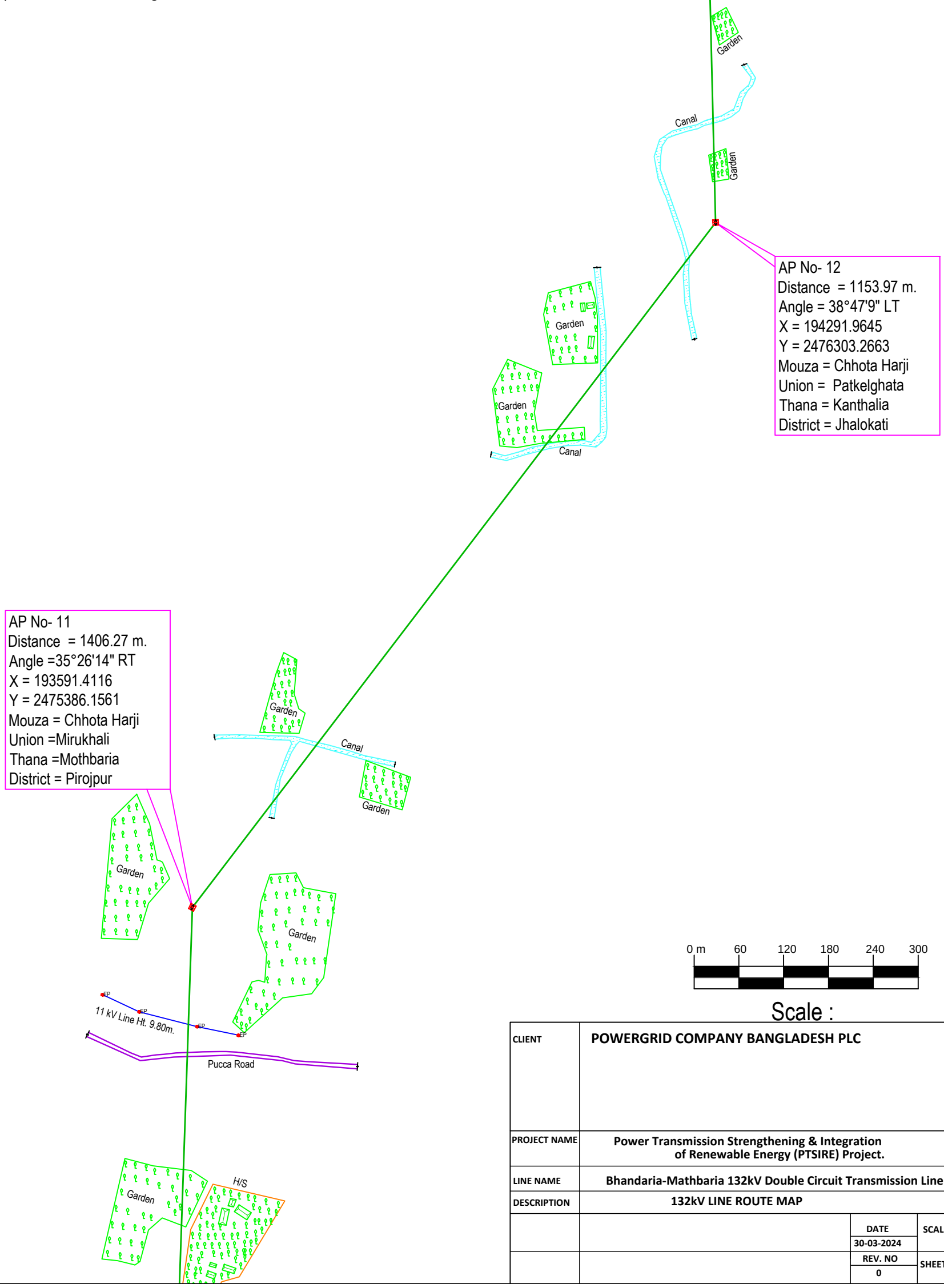
EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.



CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	07

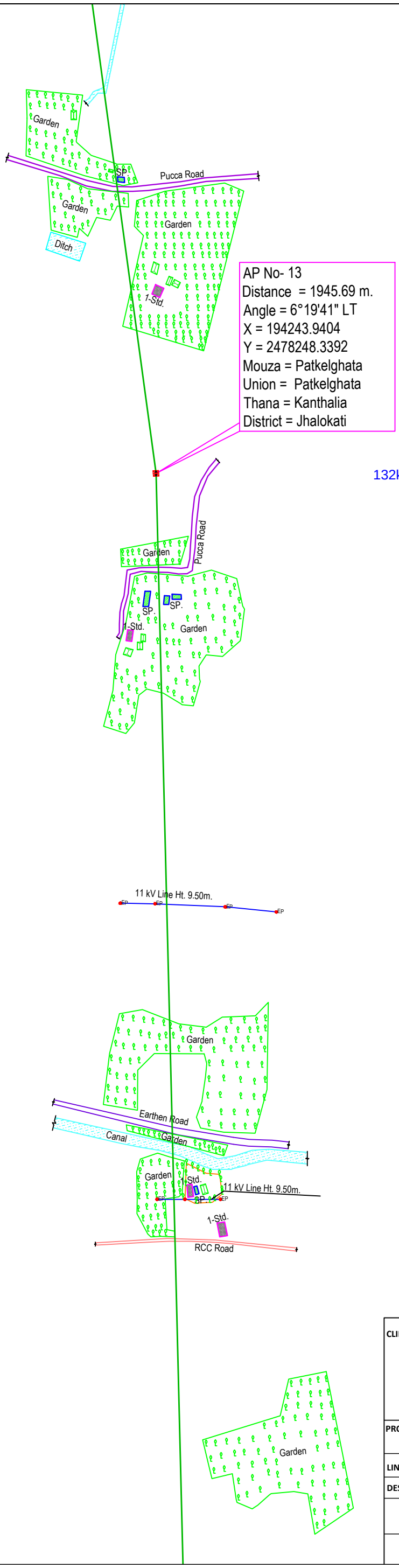


EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.



Scale :

CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	08



AP No- 13
Distance = 1945.69 m.
Angle = 6°19'41" LT
X = 194243.9404
Y = 2478248.3392
Mouza = Patkelghata
Union = Patkelghata
Thana = Kanthalia
District = Jhalokati

LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	..... EP EP
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	..... MH
Tree/Banana/Bamboo	.....	Railway Line	.....

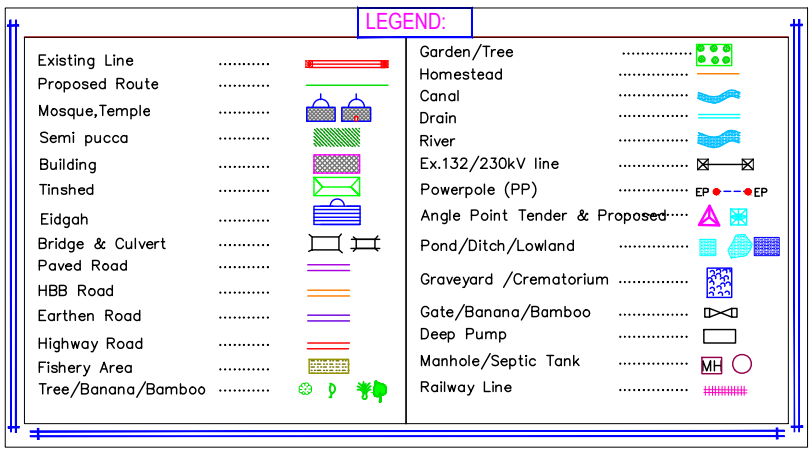
EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.

N
W E
S

0 m 60 120 180 240 300

Scale :

CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	09

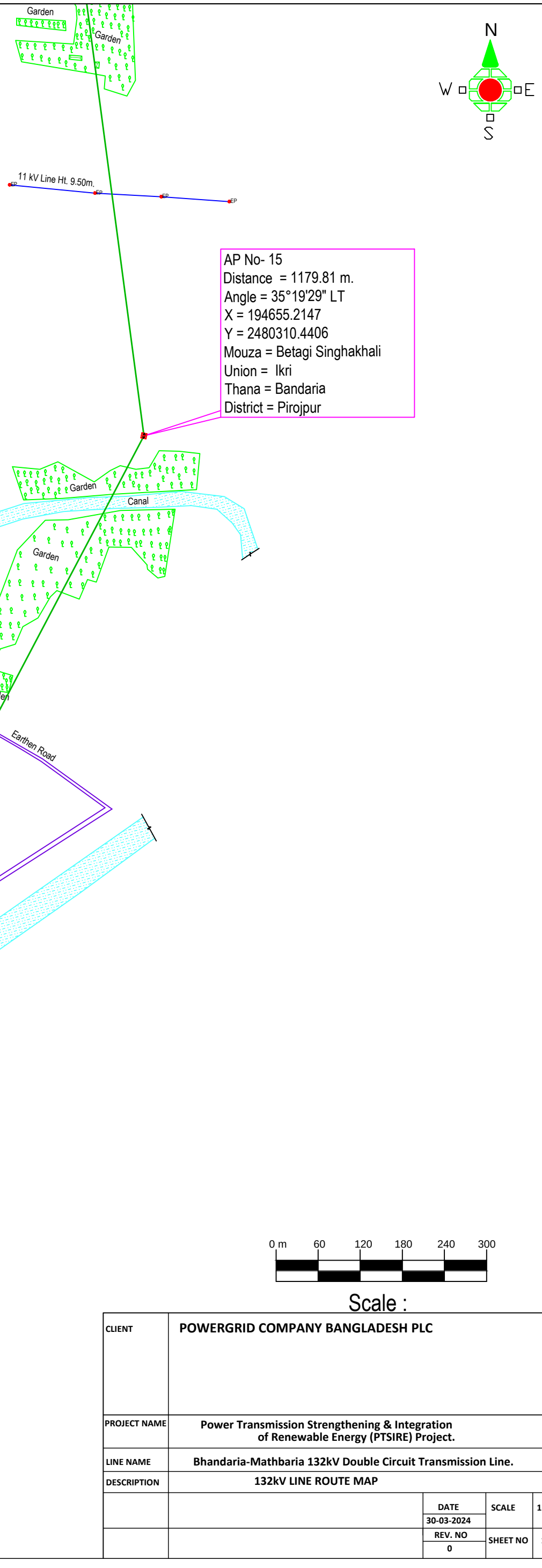


EXISTING PHYSICAL FEATURES SURVEY

132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT

Bhandaria-Mathbaria132kV Double Circuit Transmission Line

Proposed Route Total Length = 31621.00m.



Scale :

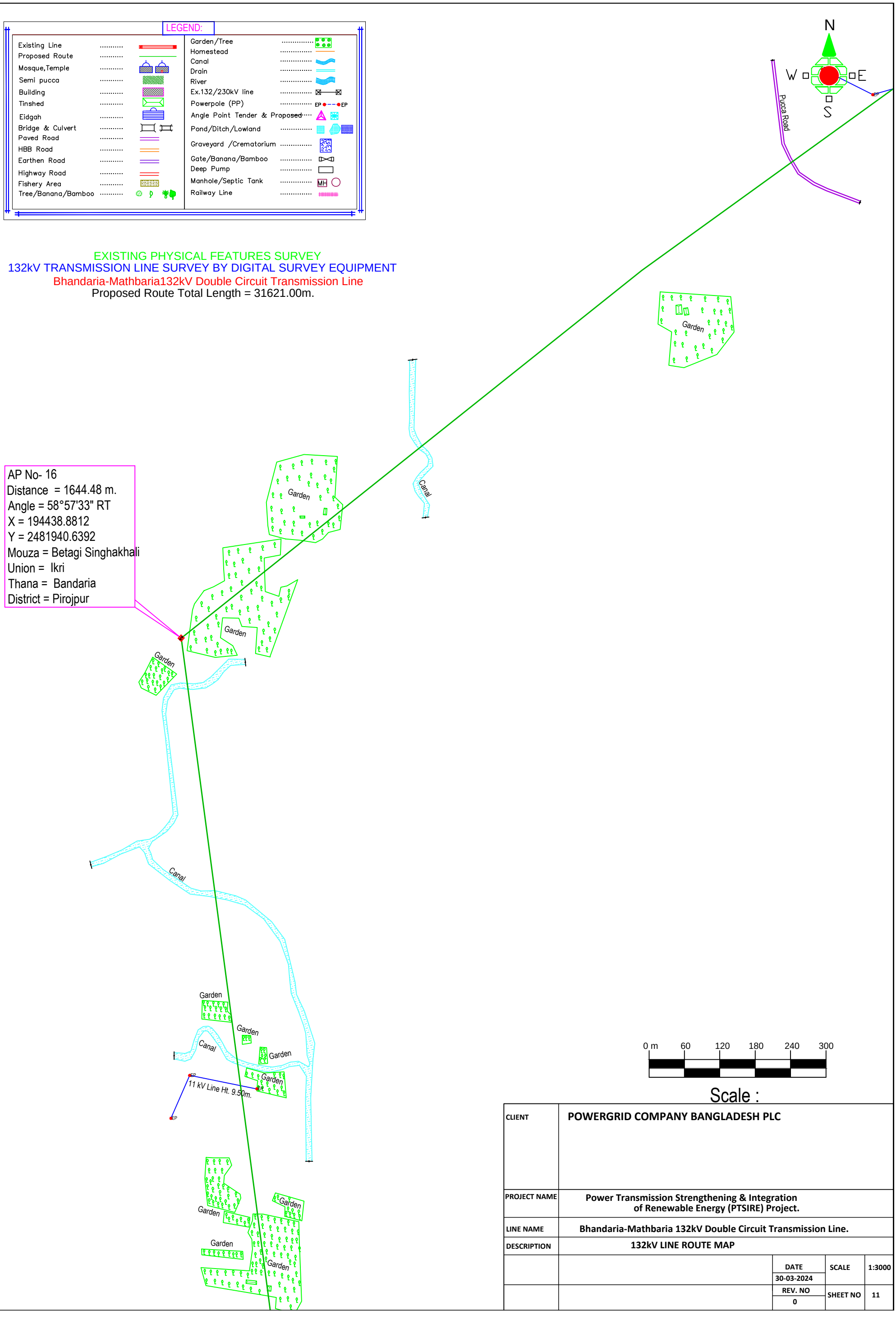
CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	10

EXISTING PHYSICAL FEATURES SURVEY

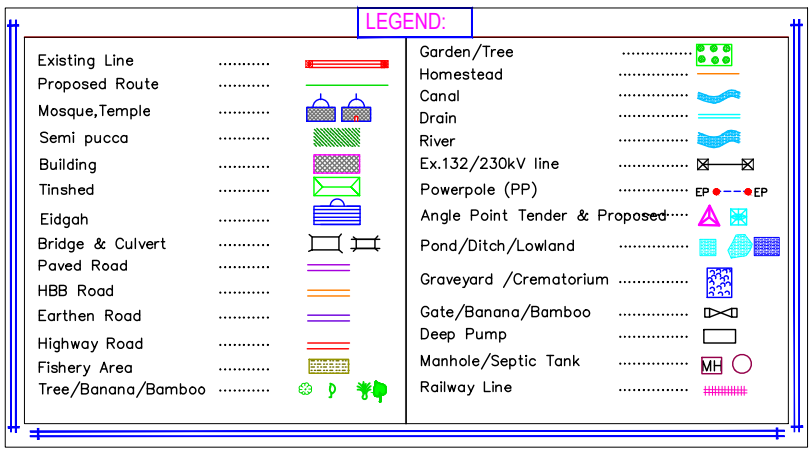
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT

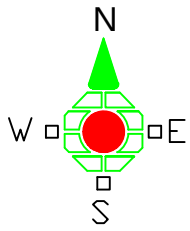
Bhandaria-Mathbaria132kV Double Circuit Transmission Line

Proposed Route Total Length = 31621.00m.



CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	11

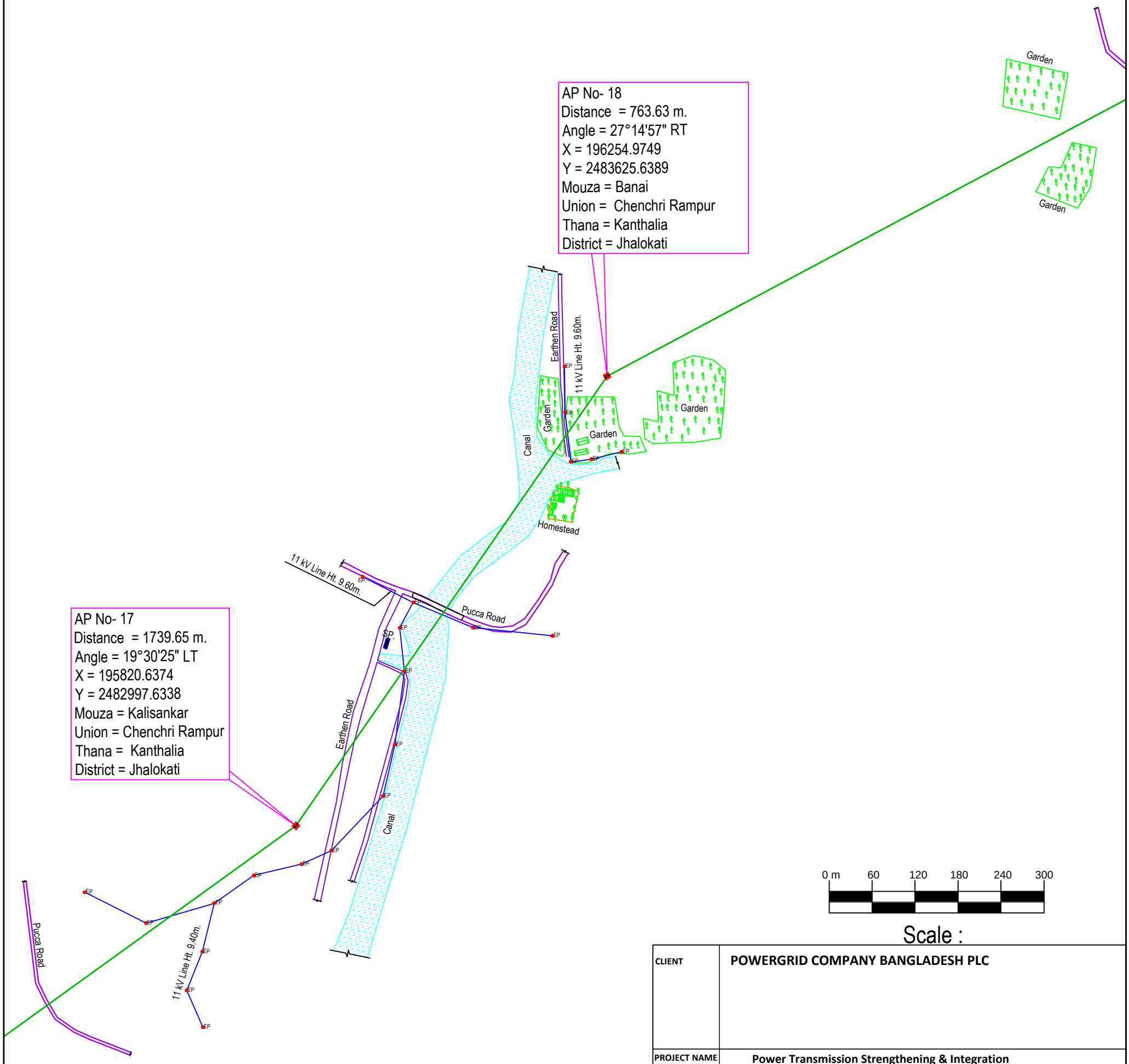




EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.

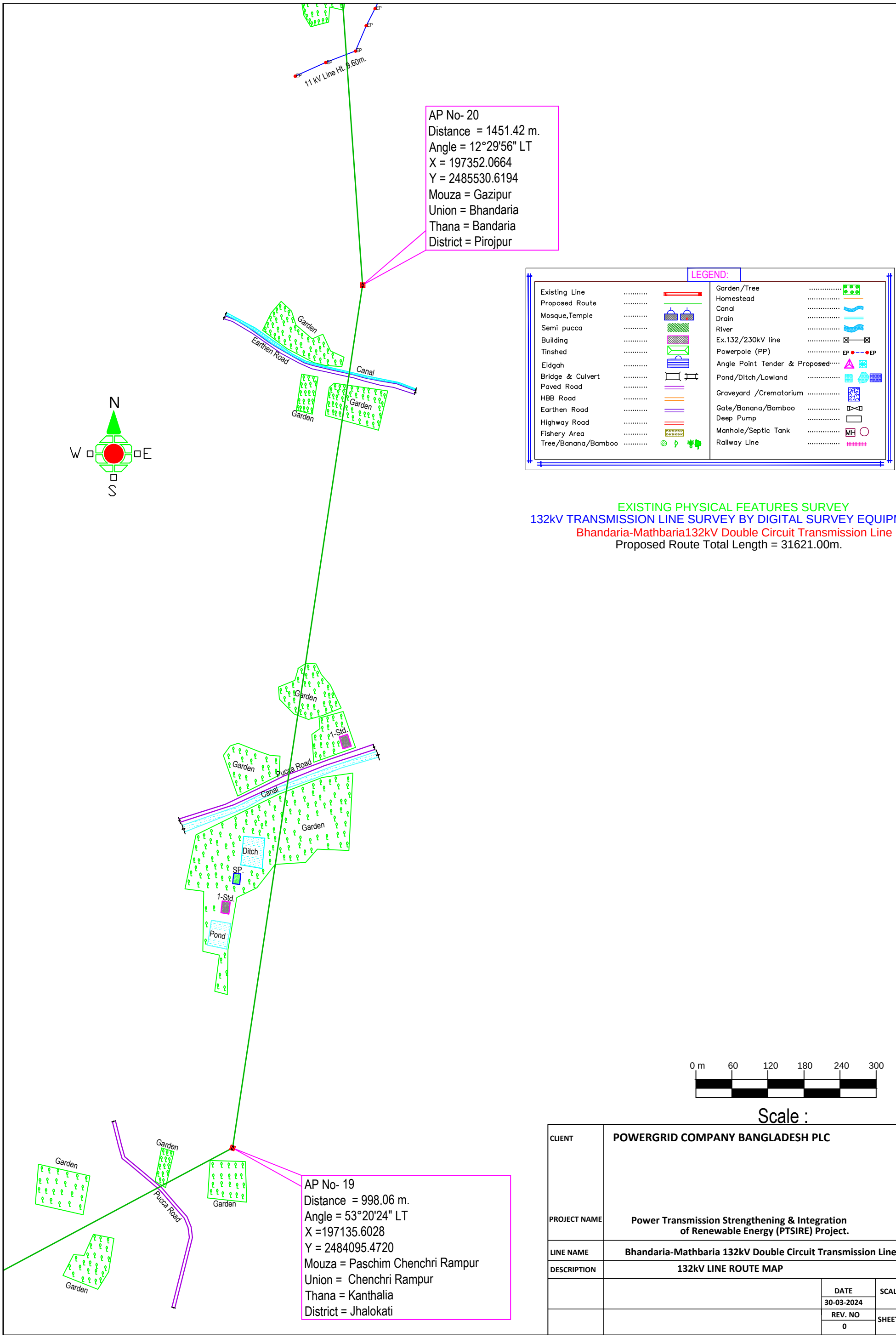
AP No- 18
Distance = 763.63 m.
Angle = 27°14'57" RT
X = 196254.9749
Y = 2483625.6389
Mouza = Banai
Union = Chenchri Rampur
Thana = Kanthalia
District = Jhalokati

AP No- 17
Distance = 1739.65 m.
Angle = 19°30'25" LT
X = 195820.6374
Y = 2482997.6338
Mouza = Kalisankar
Union = Chenchri Rampur
Thana = Kanthalia
District = Jhalokati



Scale :

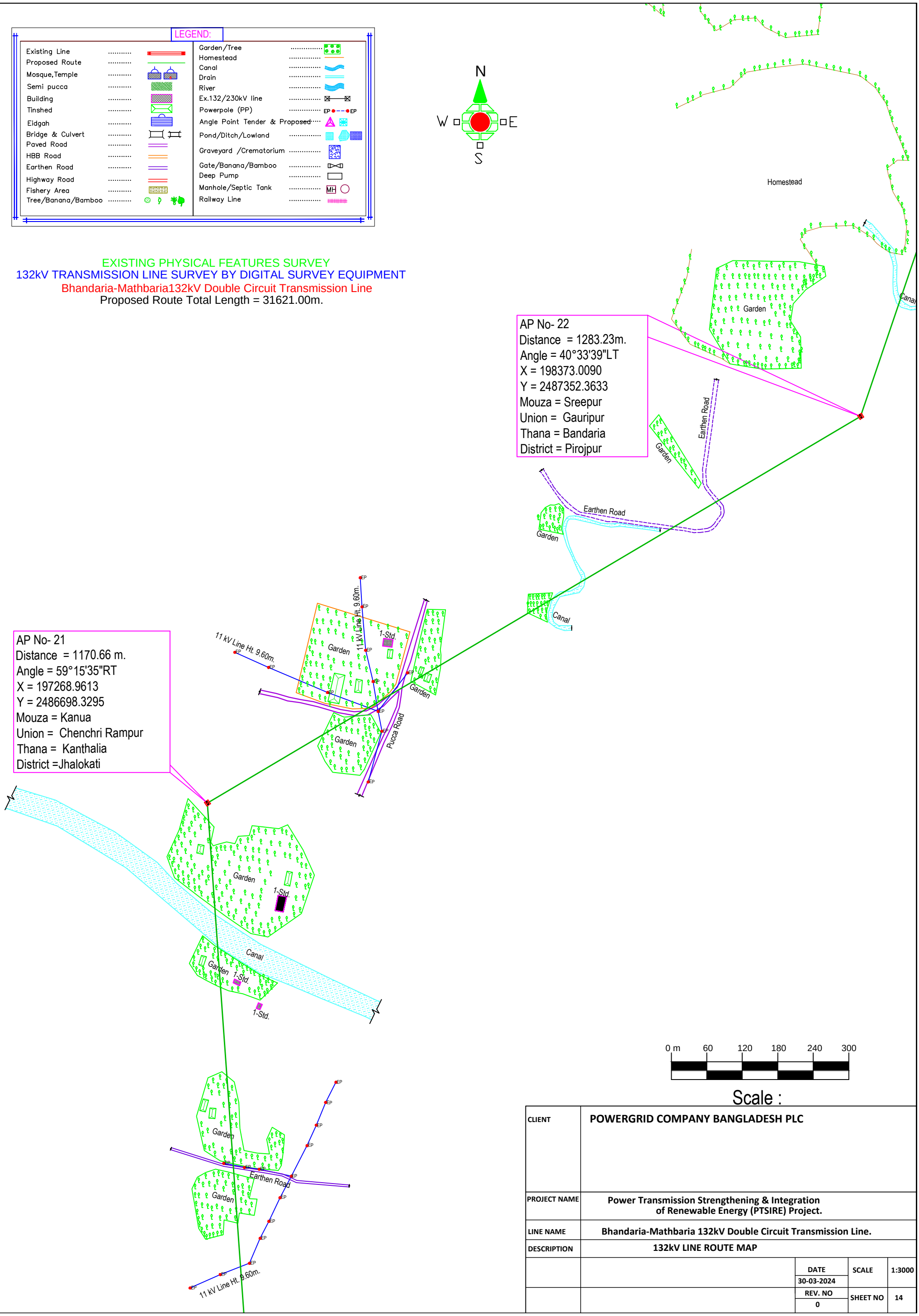
CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	12


11 kV Line Ht. 9.60m.
AP No- 20
Distance = 1451.42 m.
Angle = 12°29'56" LT
X = 197352.0664
Y = 2485530.6194
Mouza = Gazipur
Union = Bhandaria
Thana = Bandaria
District = Pirojpur
Garden
Earthen Road
Canal
Garden
Garden
N
W
E
S
Garden
1-Std.
Garden
Pucca Road
Canal
Garden
Ditch
SP.
1-Std.
Pond
Garden
Pucca Road
Garden
Garden
AP No- 19
Distance = 998.06 m.
Angle = 53°20'24" LT
X =197135.6028
Y = 2484095.4720
Mouza = Paschim Chenchri Rampur
Union = Chenchri Rampur
Thana = Kanthalia
District = Jhalokati
LEGEND:
Existing Line
Proposed Route
Mosque,Temple
Semi pucca
Building
Tinshed
Eidgah
Bridge & Culvert
Paved Road
HBB Road
Earthen Road
Highway Road
Fishery Area
Tree/Banana/Bamboo
Garden/Tree
Homestead
Canal
Drain
River
Ex.132/230kV line
Powerpole (PP)
Angle Point Tender & Proposed
Pond/Ditch/Lowland
Graveyard /Crematorium
Gate/Banana/Bamboo
Deep Pump
Manhole/Septic Tank
Railway Line
EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.
0 m 60 120 180 240 300
Scale :
CLIENT: POWERGRID COMPANY BANGLADESH PLC
PROJECT NAME: Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.
LINE NAME: Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.
DESCRIPTION: 132kV LINE ROUTE MAP
DATE: 30-03-2024
SCALE: 1:3000
REV. NO: 0
SHEET NO: 13

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.

AP No- 22
Distance = 1283.23m.
Angle = 40°33'39"LT
X = 198373.0090
Y = 2487352.3633
Mouza = Sreepur
Union = Gauripur
Thana = Bandaria
District = Pirojpur

AP No- 21
Distance = 1170.66 m.
Angle = 59°15'35"RT
X = 197268.9613
Y = 2486698.3295
Mouza = Kanua
Union = Chenchri Rampur
Thana = Kanthalia
District =Jhalokati



Scale :

CLIENT	POWERGRID COMPANY BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:3000
		REV. NO 0	SHEET NO	14

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Bhandaria-Mathbaria132kV Double Circuit Transmission Line
Proposed Route Total Length = 31621.00m.

N
W E
S

T#27
T#28
T#29

Ext. Barisal-Bhandaria-132 kV S/C Transmission Line
Ext. Bagerhat-Bhandaria- 132 kV S/C Transmission Line
Ext. Barishal-Bhandaria-132kV TL

Existing Gantry
Distance = 80.01m
X = 198448.24
Y = 2488950.19
Mouza : Bhandaria
Union : Bhandaria
Thana : Bandaria
District : Pirojpur

Existing TT- 02 (4-ckt)
With Aux-Arm
Angle- 51°25'30" RT
Distance = 223.062m
X = 198438.0123
Y = 2488870.6779
Mouza : Bhandaria
Union : Bhandaria
Thana : Bandaria
District : Pirojpur

Proposed New Gantry
Distance = 63.96m
X = 198481.27
Y = 2488935.98

Proposed TT (4-ckt)
With Aux-Arm
Angle- 70°53'23" RT
Distance = 190.03m
X = 198462.00
Y = 2488875.00
Mouza : Bhandaria
Union : Bhandaria
Thana : Bandaria
District : Pirojpur

Existing T- 40 (4-ckt)
Angle- 08°47'24" LT
Distance = 1390.85m
X = 198614.4649
Y = 2488761.5693
Mouza : Bhandaria
Union : Bhandaria
Thana : Bandaria
District : Pirojpur

Tower No = 31
Top Ht. = 35.486m
Bottom Ht. = 20.784m

Pirojpur-Bhandaria AP- 41
Angle- 54°06'05" LT
Distance = 621.992m
X = 198593.41
Y = 2488710.65
Mouza : Bhandaria
Union : Bhandaria
Thana : Bandaria
District : Pirojpur

Pirojpur-Bhandaria AP- 40
Angle- 53°23'31" RT
Distance = 626.726m
X = 198486.00
Y = 2488098.00
Mouza : Gauripur
Union : Gauripur
Thana : Bandaria
District : Pirojpur

AP No- 24
Distance =335.28m
Angle = 11°30'24" RT
X = 198479.4139
Y = 2488053.3402
Mouza = Sreepur
Union = Gauripur
Thana = Bandaria
District = Pirojpur

AP No- 23
Distance =386.82m.
Angle = 21°54'52"LT
X = 198497.6480
Y = 2487718.5532
Mouza = Sreepur
Union = Gauripur
Thana = Bandaria
District = Pirojpur

AP No- 22
Distance = 1283.23m.
Angle = 40°33'39"LT
X = 198373.0090
Y = 2487352.3633
Mouza = Sreepur
Union = Gauripur
Thana = Bandaria
District = Pirojpur

Pirojpur-Bhandaria AP- 39
Angle- 54°00'01" RT
Distance = 593.361m
X = 198917.00
Y = 2487643.00
Mouza : Gauripur
Union : Gauripur
Thana : Bandaria
District : Pirojpur

Ext. Bhandaria Sub-Station
Pucca Road
Low Land
Minister Barn
Pond
Homestead
H/S
74 No. Southeast Bhandaria Primary School
Ditch
Garden
Canal
Earthen Road
SP
1-Std.
2-Std.
3-Std.
Wall

CLIENT	POWERGRID COMPANY BANGLADESH PLC
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.
LINE NAME	Bhandaria-Mathbaria 132kV Double Circuit Transmission Line.
DESCRIPTION	132kV LINE ROUTE MAP

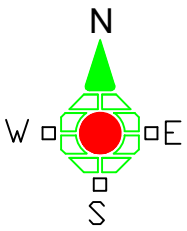
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30-03-2024		
REV. NO	SHEET NO	15
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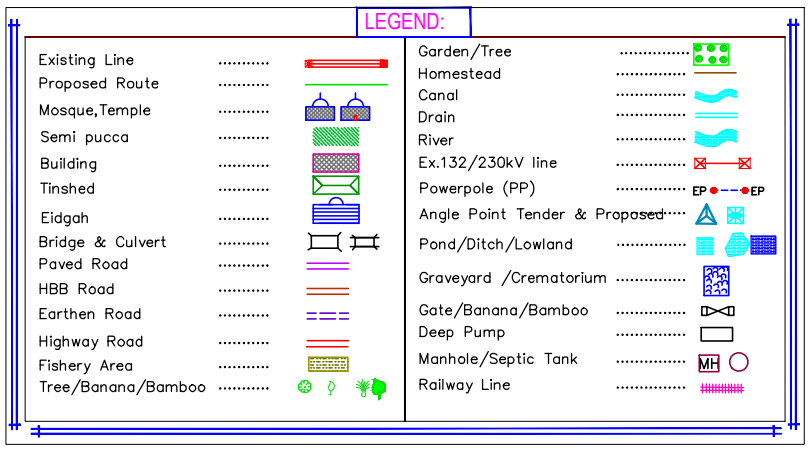
CLIENT : **POWER GRID BANGLADESH PLC**

PROJECT NAME: **Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.**

LINE NAME : Kachua-Matlab(N)132kV Double Circuit Transmission Line.

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.



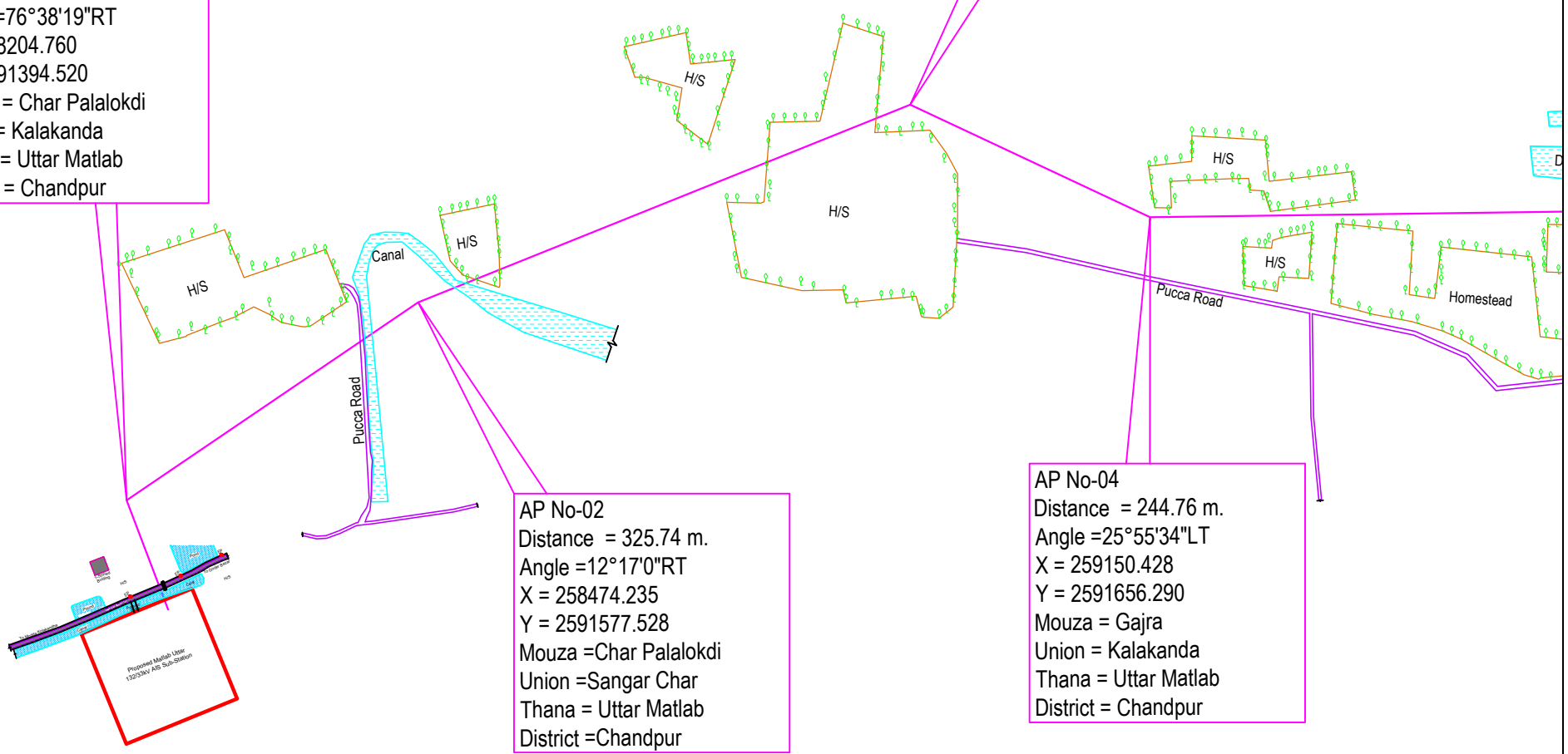


AP No-01
Distance = 108.04 m.
Angle =76°38'19"RT
X = 258204.760
Y = 2591394.520
Mouza = Char Palalokdi
Union = Kalakanda
Thana = Uttar Matlab
District = Chandpur

AP No-02
Distance = 325.74 m.
Angle =12°17'0"RT
X = 258474.235
Y = 2591577.528
Mouza =Char Palalokdi
Union =Sangar Char
Thana = Uttar Matlab
District =Chandpur

AP No-03
Distance = 489.97 m.
Angle =47°2'14"RT
X = 258928.854
Y = 2591760.268
Mouza =
Union = Kalakanda
Thana = Uttar Matlab
District = Chandpur

AP No-04
Distance = 244.76 m.
Angle =25°55'34"LT
X = 259150.428
Y = 2591656.290
Mouza = Gajra
Union = Kalakanda
Thana = Uttar Matlab
District = Chandpur

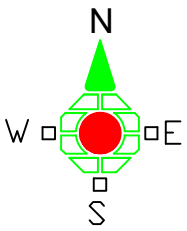


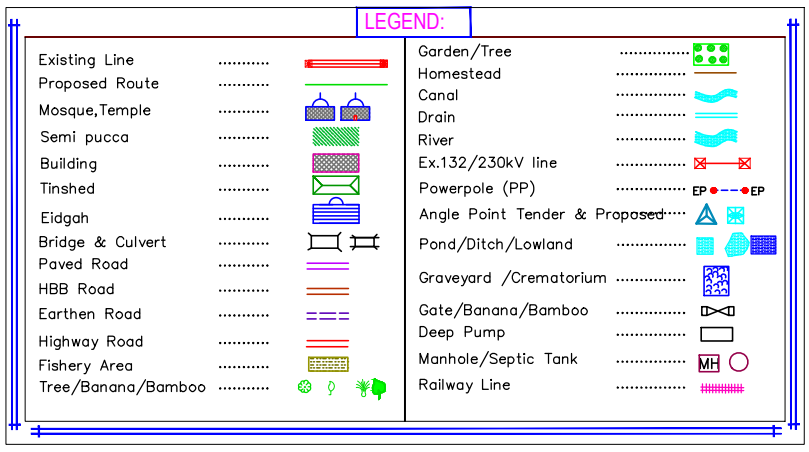
0 m 60 120 180 240 300

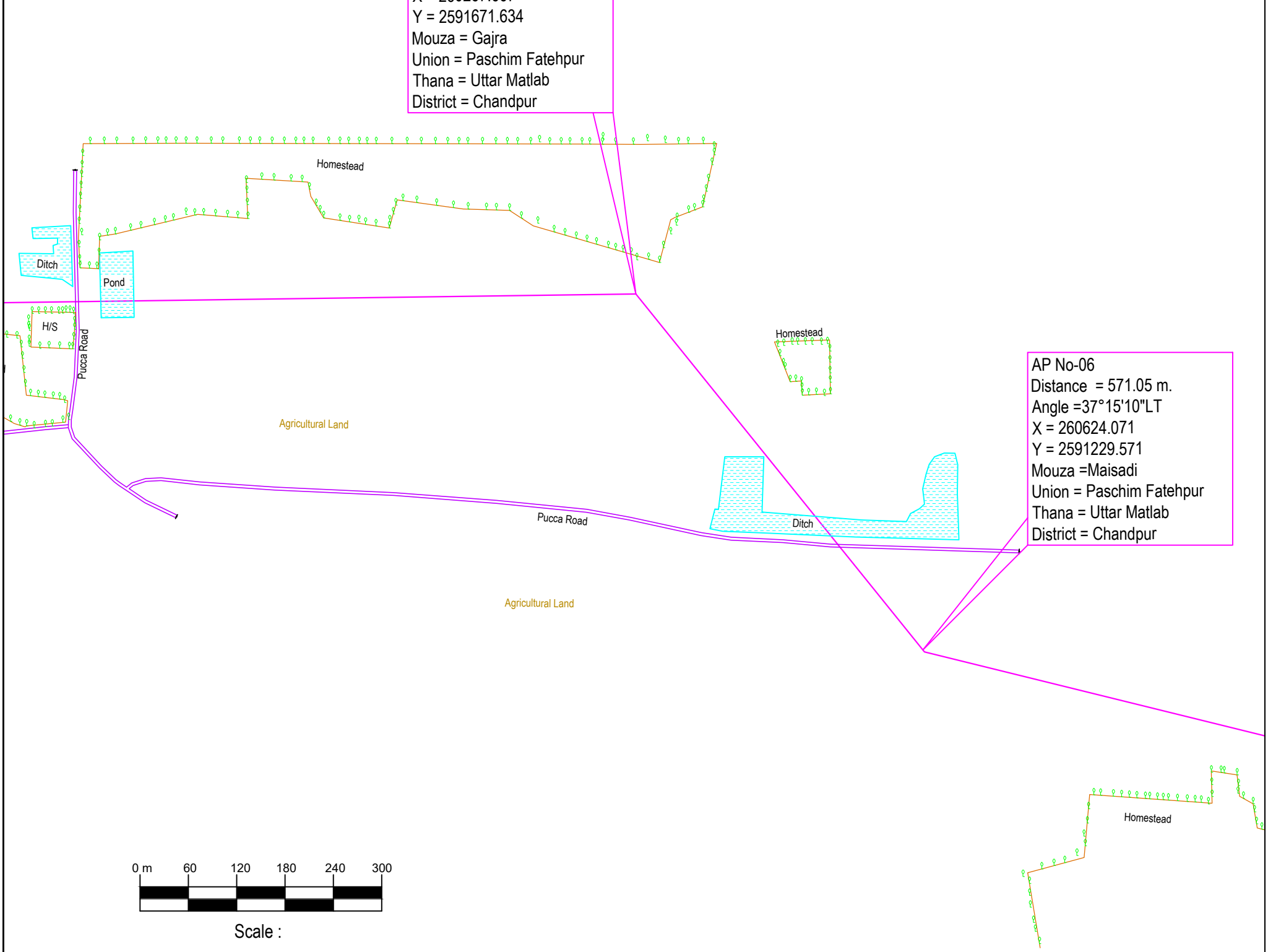
Scale :

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	01

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.



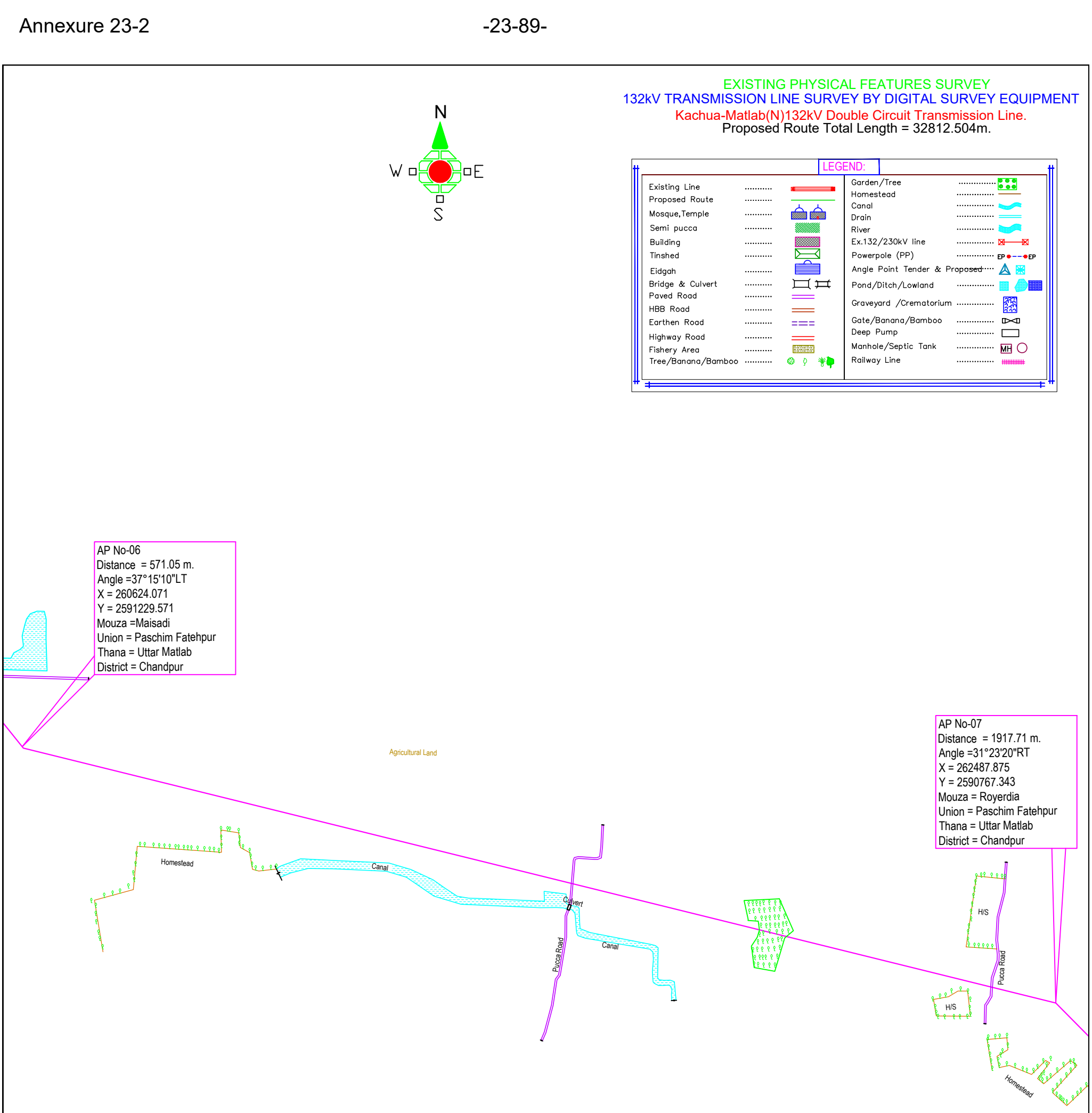




Scale :

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	02

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

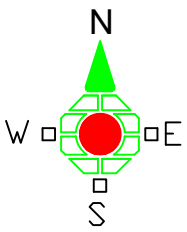


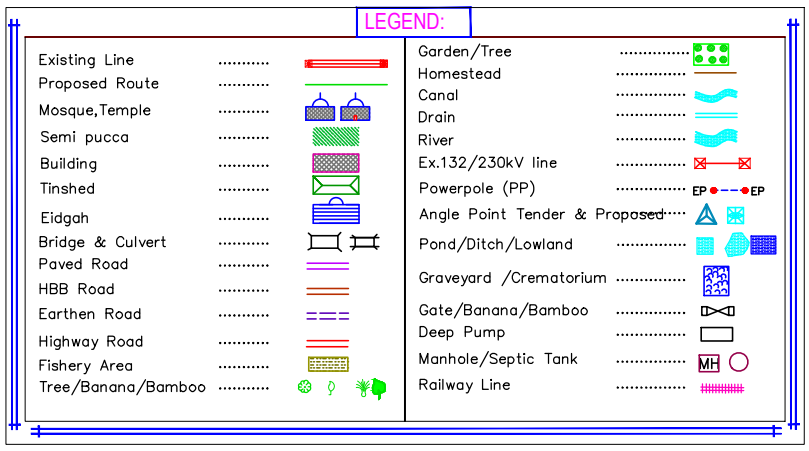


Scale :

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	03

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

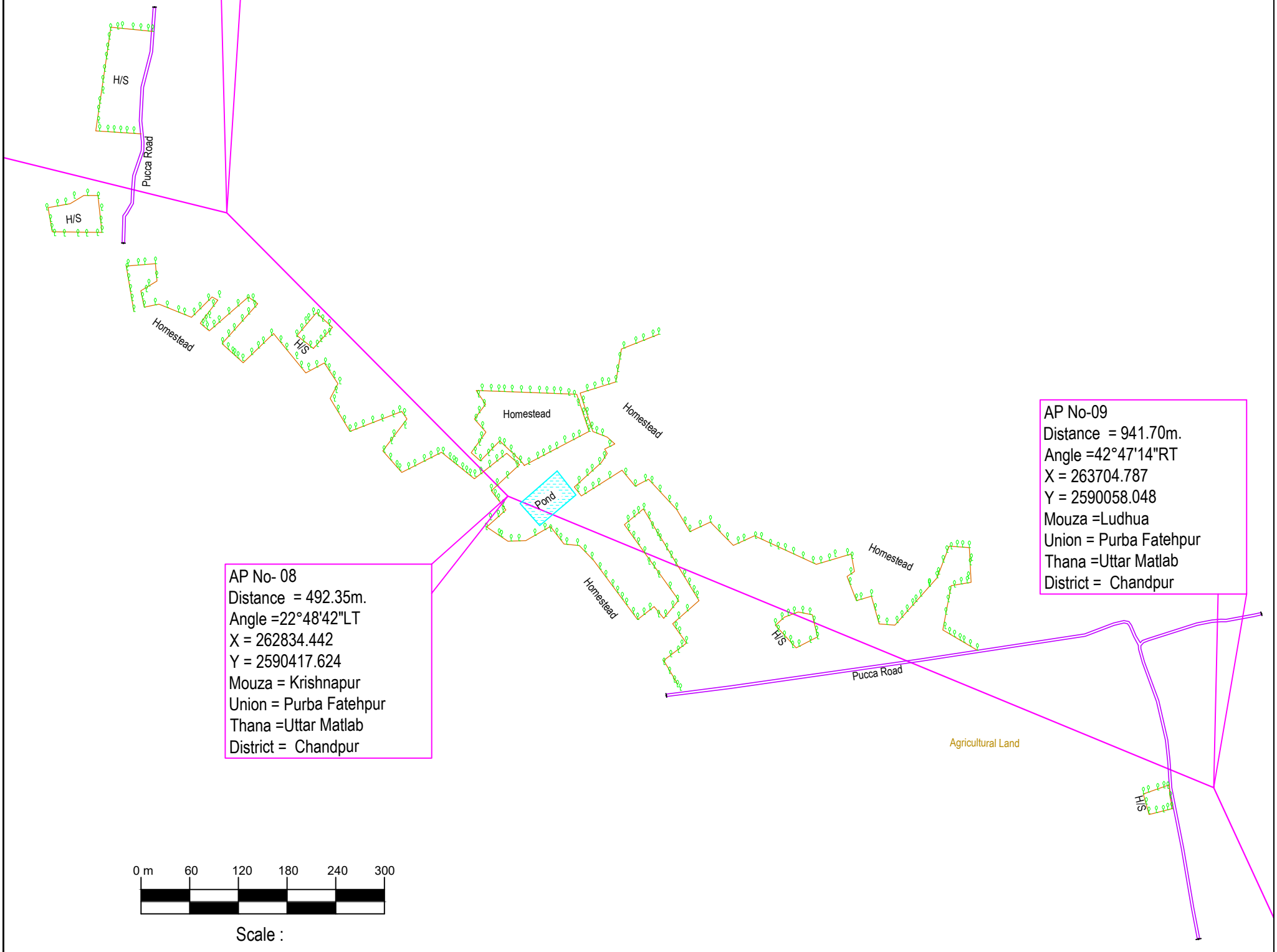




AP No-07
Distance = 1917.71 m.
Angle =31°23'20"RT
X = 262487.875
Y = 2590767.343
Mouza = Royerdia
Union = Paschim Fatehpur
Thana = Uttar Matlab
District = Chandpur

AP No- 08
Distance = 492.35m.
Angle =22°48'42"LT
X = 262834.442
Y = 2590417.624
Mouza = Krishnapur
Union = Purba Fatehpur
Thana =Uttar Matlab
District = Chandpur

AP No-09
Distance = 941.70m.
Angle =42°47'14"RT
X = 263704.787
Y = 2590058.048
Mouza =Ludhua
Union = Purba Fatehpur
Thana =Uttar Matlab
District = Chandpur



Scale :

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	04

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

N
W E
S

LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	..... EP EP
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	..... MH
Tree/Banana/Bamboo	.....	Railway Line	.....

AP No-09
Distance = 941.70m.
Angle =42°47'14"RT
X = 263704.787
Y = 2590058.048
Mouza =Ludhua
Union = Purba Fatehpur
Thana =Uttar Matlab
District = Chandpur

AP No-10
Distance = 618.13 m.
Angle =29°49'15"LT
X = 263963.722
Y = 2589496.763
Mouza = Ludhua
Union = Purba Fatehpur
Thana =Uttar Matlab
District = Chandpur

AP No-11
Distance = 372.60 m.
Angle =41°21'41"LT
X = 264267.386
Y = 2589280.848
Mouza =Nanderkandi
Union = Purba Fatehpur
Thana =Uttar Matlab
District = Chandpur

AP No-12
Distance = 197.28 m.
Angle =33°30'5"RT
X = 264463.600
Y = 2589301.288
Mouza =Nanderkandi
Union = Purba Fatehpur
Thana =Uttar Matlab
District = Chandpur

Agricultural Land
Agricultural Land
H/S
Canal
Canal
H/S
Homestead
Homestead
Homestead
Garden
Pucca Road
Homestead
Homestead
Canal
Homestead

0 m 60 120 180 240 300
Scale :

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	05

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

N
W E
S

LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	..... EP EP
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	..... MH
Tree/Banana/Bamboo	.....	Railway Line	.....

AP No-12
Distance = 197.28 m.
Angle =33°30'5"RT
X = 264463.600
Y = 2589301.288
Mouza =Nanderkandi
Union = Purba Fatehpur
Thana =Uttar Matlab
District = Chandpur

AP No- 13
Distance = 1294.20m.
Angle =37°32'37"RT
X = 265611.007
Y = 2588702.608
Mouza = Faridkandi
Union = Sultanabad
Thana = Uttar Matlab
District = Chandpur

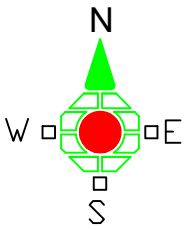
Homestead
Canal
Homestead
Homestead
Agricultural Land
Agricultural Land
Canal
Pucca Road
H/S
Canal
Pucca Road
Canal

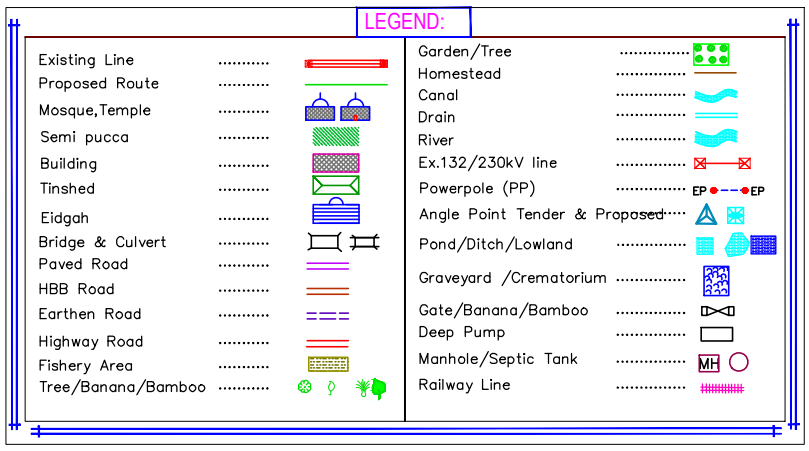
0 m 60 120 180 240 300

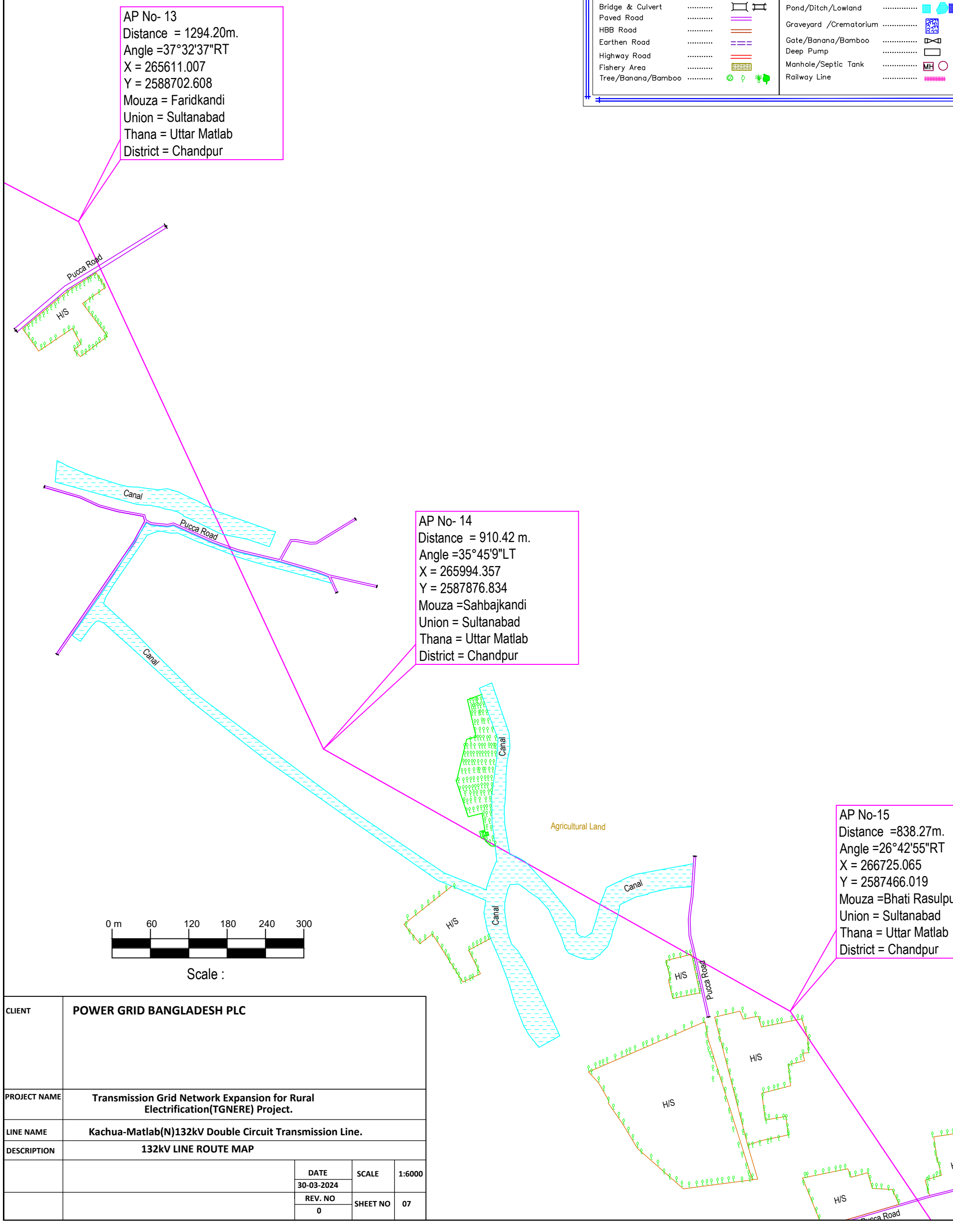
Scale :

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	06

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

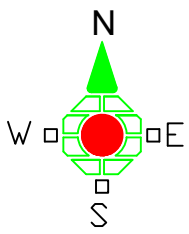


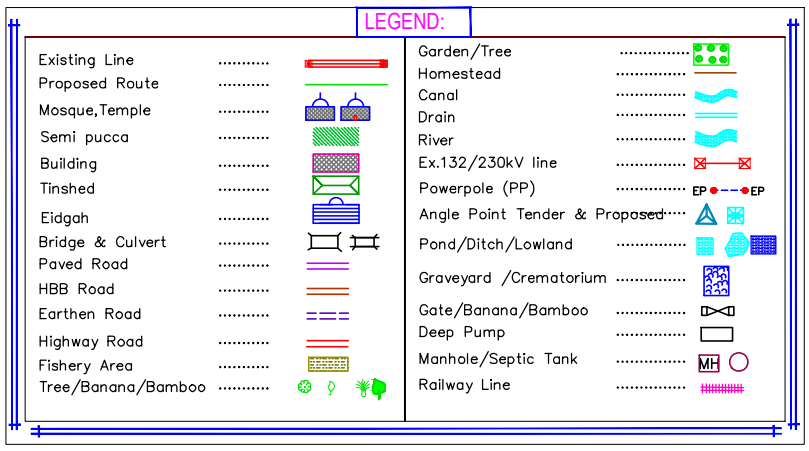


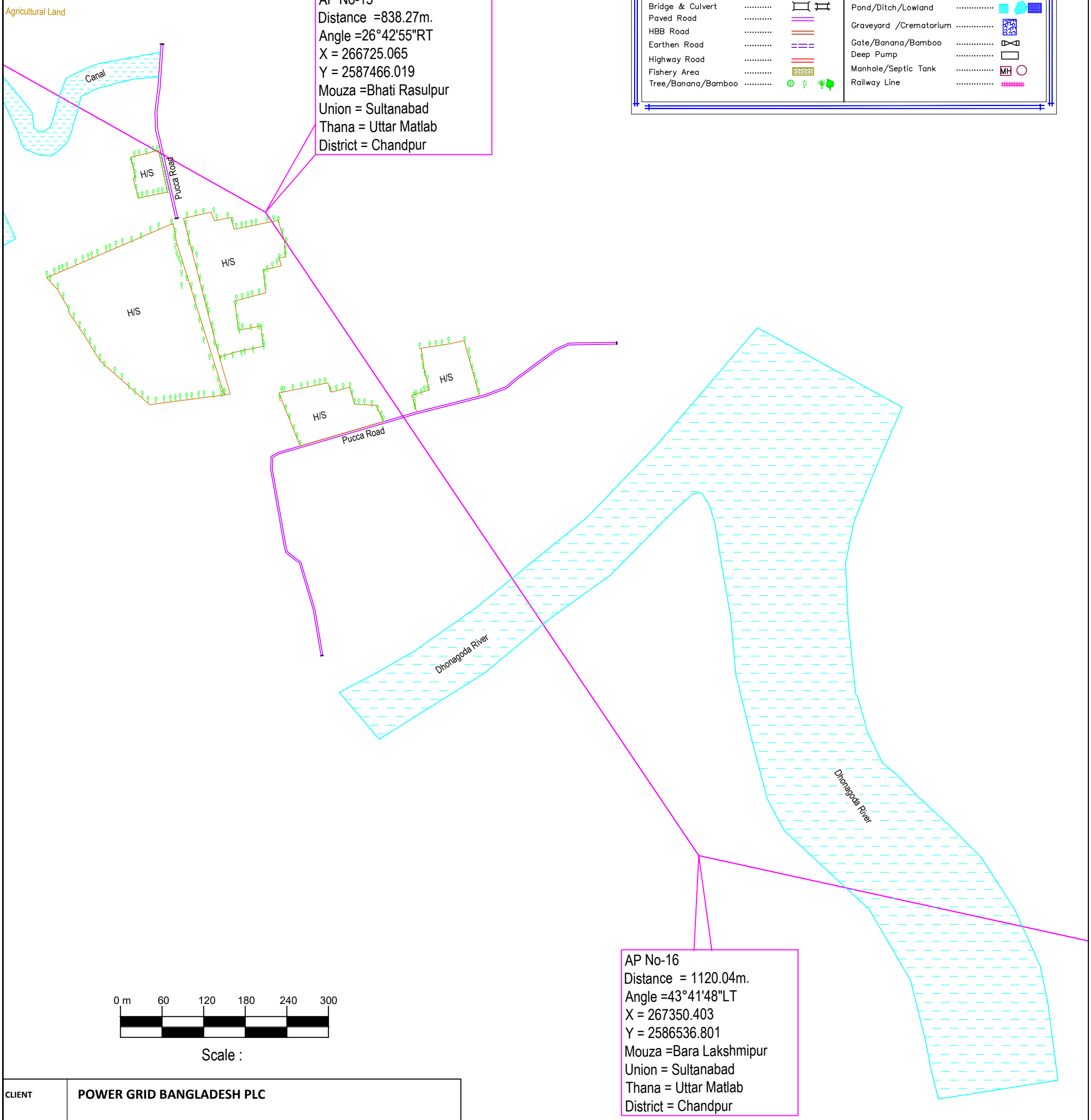


CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	07

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.



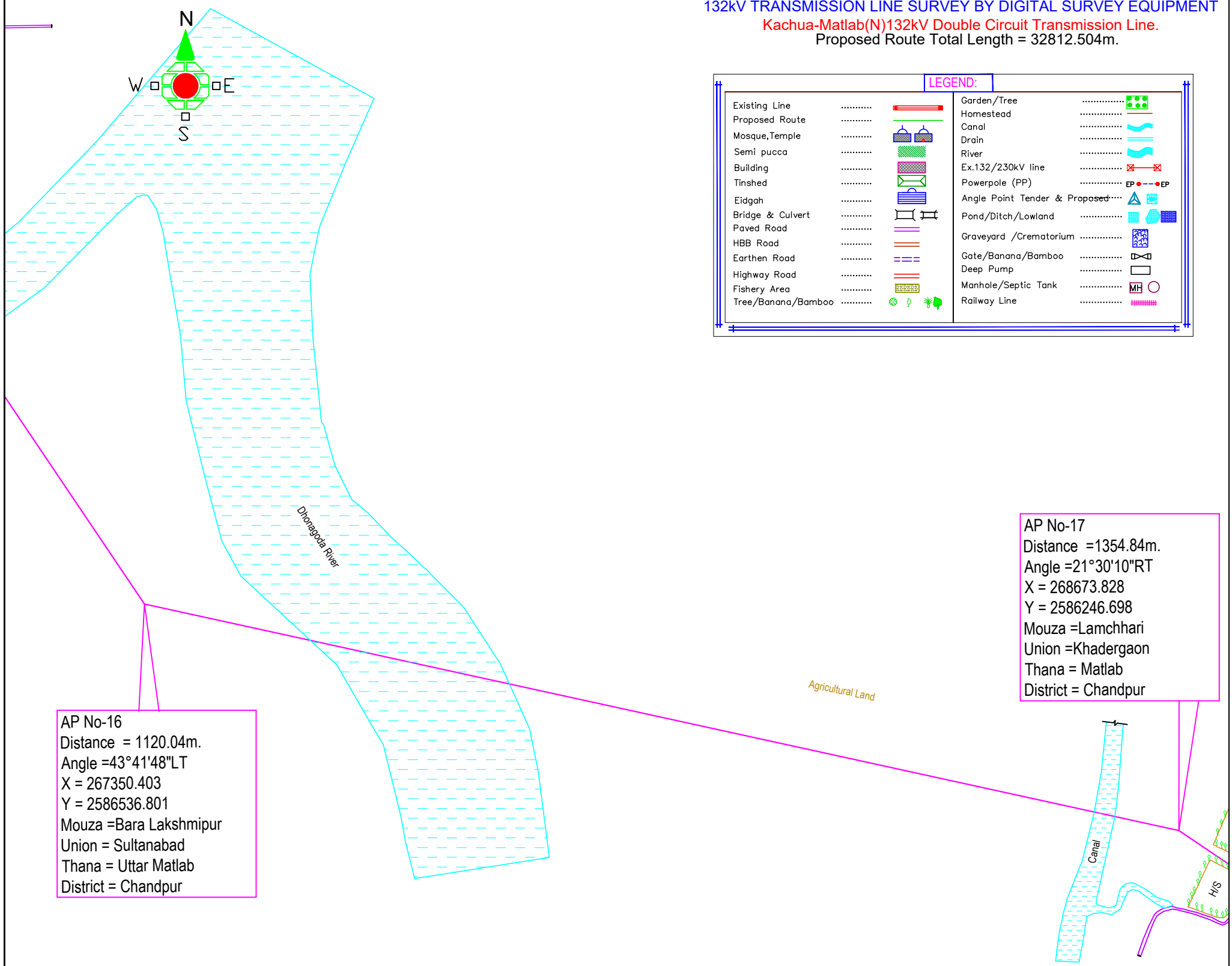


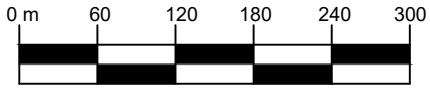


Scale :

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	08

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

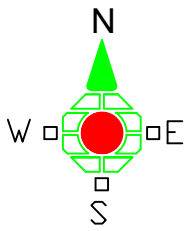


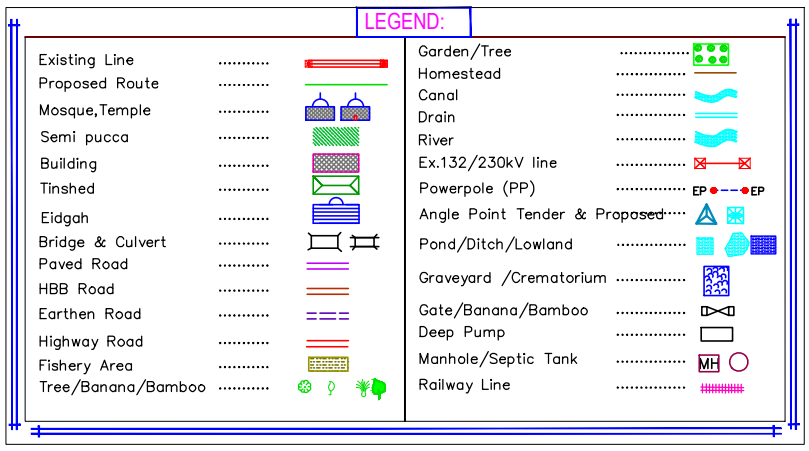


Scale :

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	09

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.



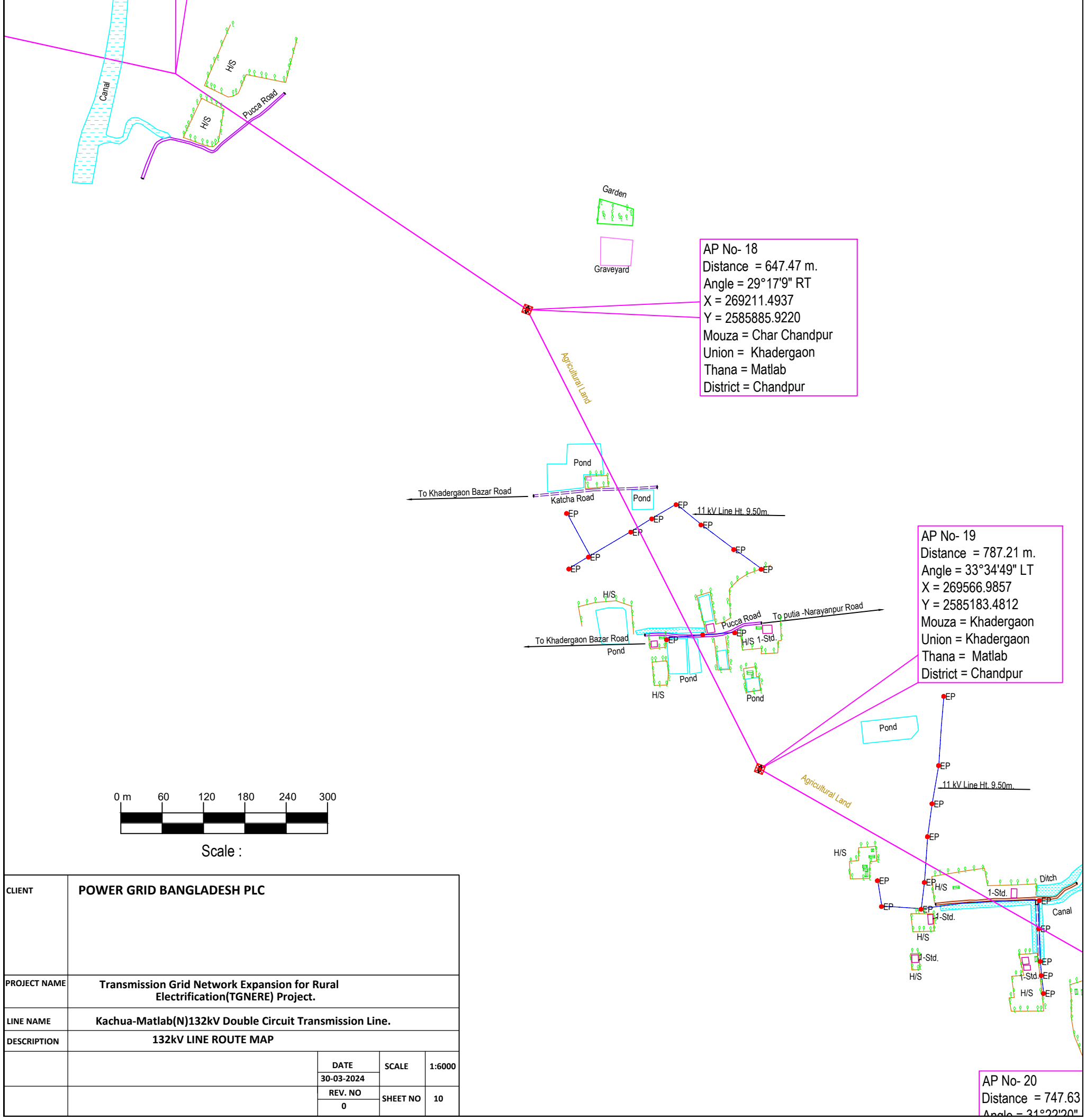


AP No-17
Distance =1354.84m.
Angle =21°30'10"RT
X = 268673.828
Y = 2586246.698
Mouza =Lamchhari
Union =Khadergaon
Thana = Matlab
District = Chandpur

AP No- 18
Distance = 647.47 m.
Angle = 29°17'9" RT
X = 269211.4937
Y = 2585885.9220
Mouza = Char Chandpur
Union = Khadergaon
Thana = Matlab
District = Chandpur

AP No- 19
Distance = 787.21 m.
Angle = 33°34'49" LT
X = 269566.9857
Y = 2585183.4812
Mouza = Khadergaon
Union = Khadergaon
Thana = Matlab
District = Chandpur

AP No- 20
Distance = 747.63
Angle = 31°22'20"



0 m 60 120 180 240 300

Scale :

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE	SCALE	1:6000
		30-03-2024		
		REV. NO	SHEET NO	10
		0		

= 29°17'9" RT
69211.4937
585885.9220
a = Char Chandpur
= Khadergaon
a = Matlab
ct = Chandpur

N
W E
S

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	..... EP EP
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	..... MH
Tree/Banana/Bamboo	.....	Railway Line	.....

AP No- 19
Distance = 787.21 m.
Angle = 33°34'49" LT
X = 269566.9857
Y = 2585183.4812
Mouza = Khadergaon
Union = Khadergaon
Thana = Matlab
District = Chandpur

AP No- 20
Distance = 747.63 m.
Angle = 31°22'20" LT
X = 270218.0402
Y = 2584814.0889
Mouza = Nagdah
Union = Khadergaon
Thana = Matlab
District = Chandpur

AP No- 21
Distance = 260.00 m.
Angle = 32°55'58" RT
X = 270477.0409
Y = 2584822.6784
Mouza = Nagdah
Union = Khadergaon
Thana = Matlab
District = Chandpur

AP No- 22
Distance =568.39 m.
Angle = 46°29'41" RT
X = 270963.5684
Y = 2584528.8079
Mouza = Nagdah
Union = Khadergaon
Thana = Matlab
District =Chandpur

Ht. 9.50m.
EP
To putia -Narayanpur Road
H/S 1-Std.
Pond
11 kV Line Ht. 9.50m.
Agricultural Land
Ditch
Canal
1-Std.
Pond
Mosque
To Putia -nagda bazar Road
Graveyard
Pucca Road
SP.
H/S
To Nagda BazarRoad
Low Land
ToNagda Govt. primary School Road
To South Nagda Government Primary School Road

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE	SCALE	1:6000
		30-03-2024		
		REV. NO	SHEET NO	11
		0		

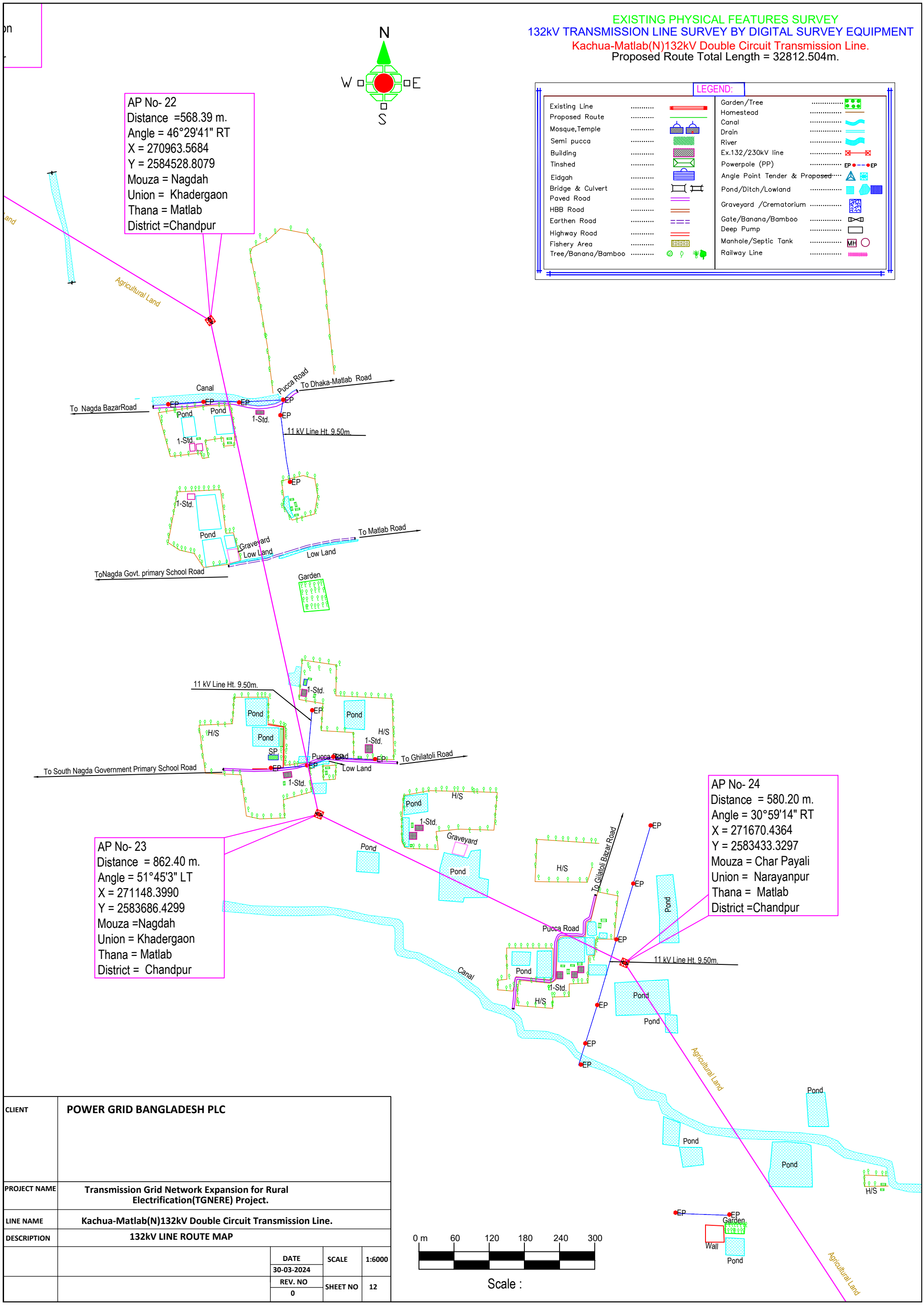
0 m 60 120 180 240 300
Scale :

EXISTING PHYSICAL FEATURES SURVEY

132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT

Kachua-Matlab(N)132kV Double Circuit Transmission Line.

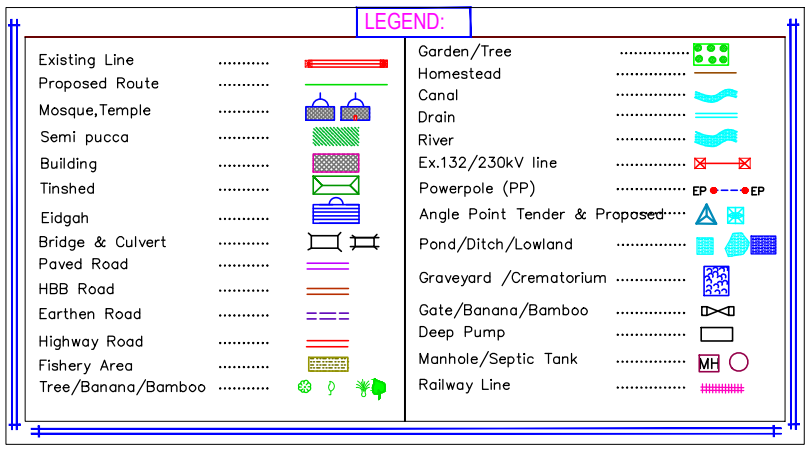
Proposed Route Total Length = 32812.504m.

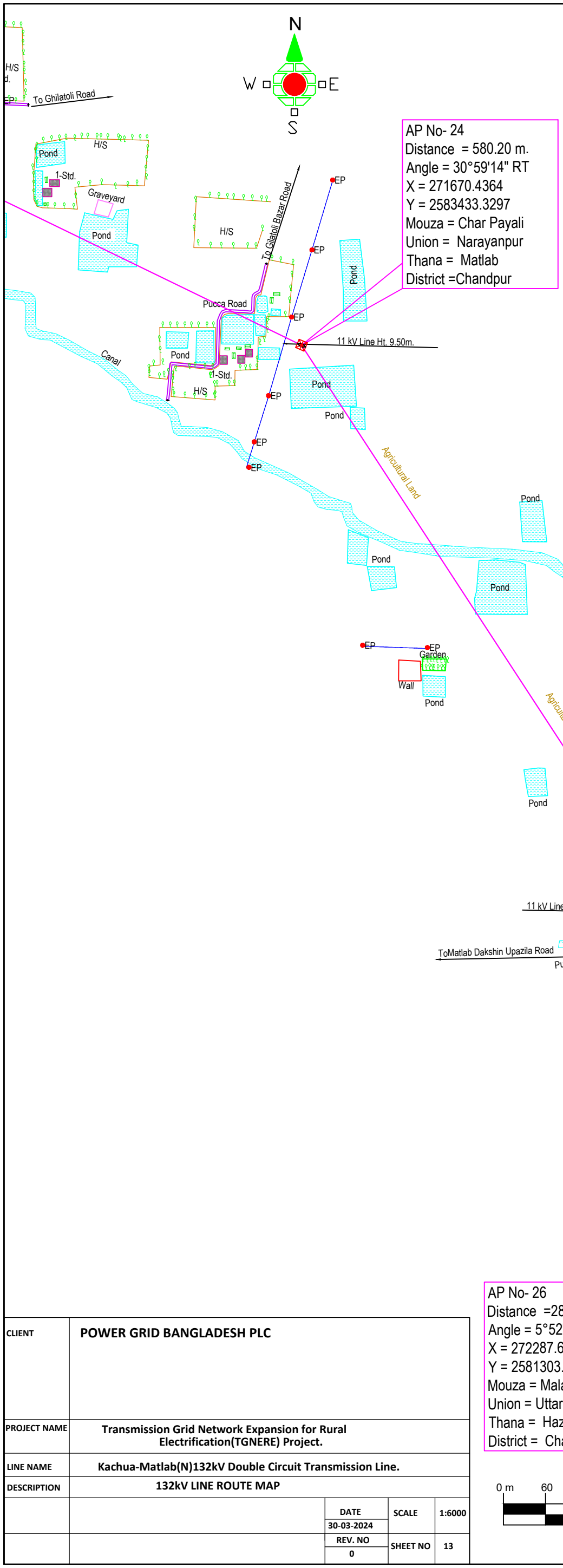


CLIENT	POWER GRID BANGLADESH PLC
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.
DESCRIPTION	132kV LINE ROUTE MAP

DATE	30-03-2024	SCALE	1:6000
REV. NO	0	SHEET NO	12

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

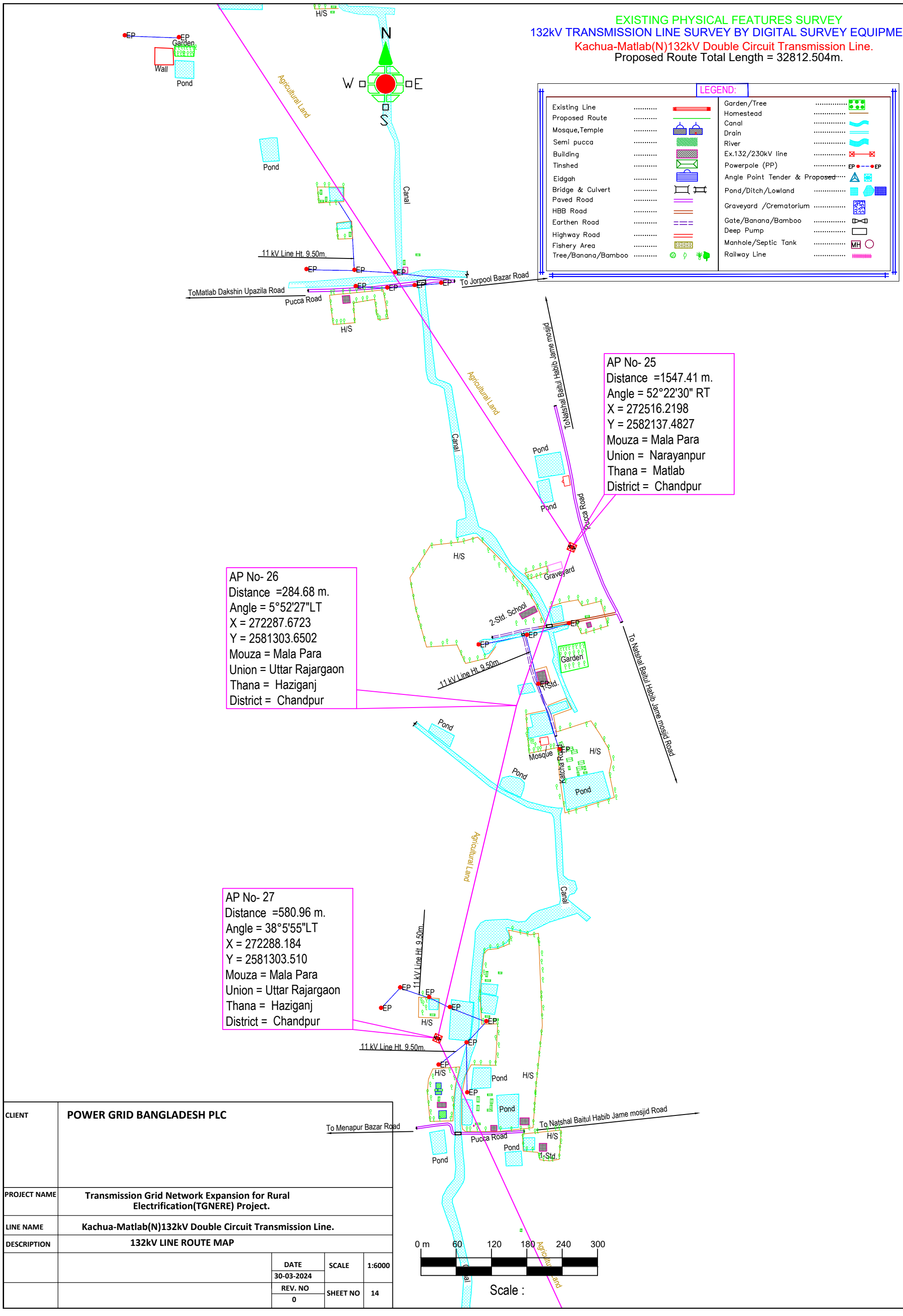




CLIENT	POWER GRID BANGLADESH PLC
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.
DESCRIPTION	132kV LINE ROUTE MAP

DATE	SCALE	1:6000
30-03-2024		
REV. NO	SHEET NO	13
0		

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.



CLIENT	POWER GRID BANGLADESH PLC
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.
DESCRIPTION	132kV LINE ROUTE MAP

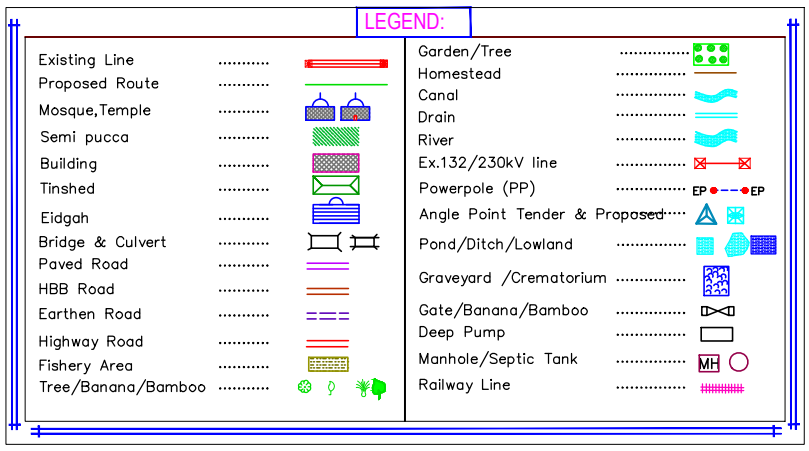
DATE	SCALE	1:6000
30-03-2024		
REV. NO	SHEET NO	14
0		

EXISTING PHYSICAL FEATURES SURVEY

132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT

Kachua-Matlab(N)132kV Double Circuit Transmission Line.

Proposed Route Total Length = 32812.504m.





CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	15

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

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LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	..... EP EP
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	..... MH
Tree/Banana/Bamboo	.....	Railway Line	.....

AP No- 28
Distance = 2362.52 m.
Angle = 57°27'58" LT
X = 273276.6864
Y = 2579157.7936
Mouza = Ichhapur
Union = Uttar Rajargaon
Thana = Haziganj
District = Chandpur

AP No- 29
Distance = 719.52 m.
Angle = 24°48'3" RT
X = 273985.6918
Y = 2579035.2624
Mouza = Kirtankhola
Union = Uttar Kalocho
Thana = Haziganj
District = Chandpur

Agricultural Land
Agricultural Land
To Road
H/S
1-Std.
EP
11 kV Line Ht. 9.50m.
Canal
Graveyard
Katcha Road
To Ichapura Govt. primary School Road
11 kV Line Ht. 9.50m.
Pucca Road
SP.
2-Std.
Pond
Pucca Road Bridge
To Kashimpur-Balakhal Road
Bridge
Agricultural Land
Garden
Katcha Road

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	16

0 m 60 120 180 240 300
Scale :

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

N
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LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	..... EP EP
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	..... MH
Tree/Banana/Bamboo	.....	Railway Line	.....

AP No- 29
Distance = 719.52 m.
Angle = 24°48'3" RT
X = 273985.6918
Y = 2579035.2624
Mouza = Kirtankhola
Union = Uttar Kalocho
Thana = Haziganj
District = Chandpur

AP No- 30
Distance = 1203.98 m.
Angle = 24°17'23" LT
X = 274951.1473
Y = 2578315.4977
Mouza = Naohata
Union = Dakshin Kalocho
Thana = Haziganj
District = Chandpur

1-Std. Pond EP H/S SP. 1-Std. 1-Std. To Kashimpur-Balakhal Road Pond Bridge Graveyard Pond H/S Agricultural Land
To Kashimpur-Balakhal Road EP EP 11 kV Line Ht. 9.50m. Pond EP EP EP EP EP Canal Pond Pond EP EP Garden Pond Katcha Road Pond
To Ichapura Govt. primary School Road
Pond Garden Mahaguni Ht. 14.70m Pond Mahaguni Ht. 13.0m Garden H/S 1-Std. Agricultural Land Pond

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	17

0 m 60 120 180 240 300
Scale :

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

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LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	..... EP EP
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	..... MH
Tree/Banana/Bamboo	.....	Railway Line	.....

AP No- 30
Distance = 1203.98 m.
Angle = 24°17'23" LT
X = 274951.1473
Y = 2578315.4977
Mouza = Naohata
Union = Dakshin Kalocho
Thana = Haziganj
District = Chandpur

AP No- 32
Distance = 517.20 m.
Angle = 42°8'6" RT
X = 275817.9797
Y = 2578550.1620
Mouza = Bhatra
Union = Dakshin Kalocho
Thana = Haziganj
District = Chandpur

AP No- 31
Distance = 487.87 m.
Angle = 53°24'0" LT
X = 275427.6936
Y = 2578210.8533
Mouza = Nurpur
Union = Dakshin Kalocho
Thana = Haziganj
District = Chandpur

Pond
Mahaguni Ht. 13.0m
Garden
H/S
1-Std.
Ht. 14.70m
Agricultural Land
Pond
Pond
Pond
H/S
U/C.
2-Std. School
SP.
EP
To Road
Market
1-Std.
Pond
SP.
Pond
SP.
1-Std.
2-Std.
Pucca Road
Graveyard
To Bangali Bazar Road
Low Land
Agricultural Land
11 kV Line Ht. 9.50m.
Agricultural Land
Kachua Road
H/S

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	18

0 m 60 120 180 240 300
Scale :

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

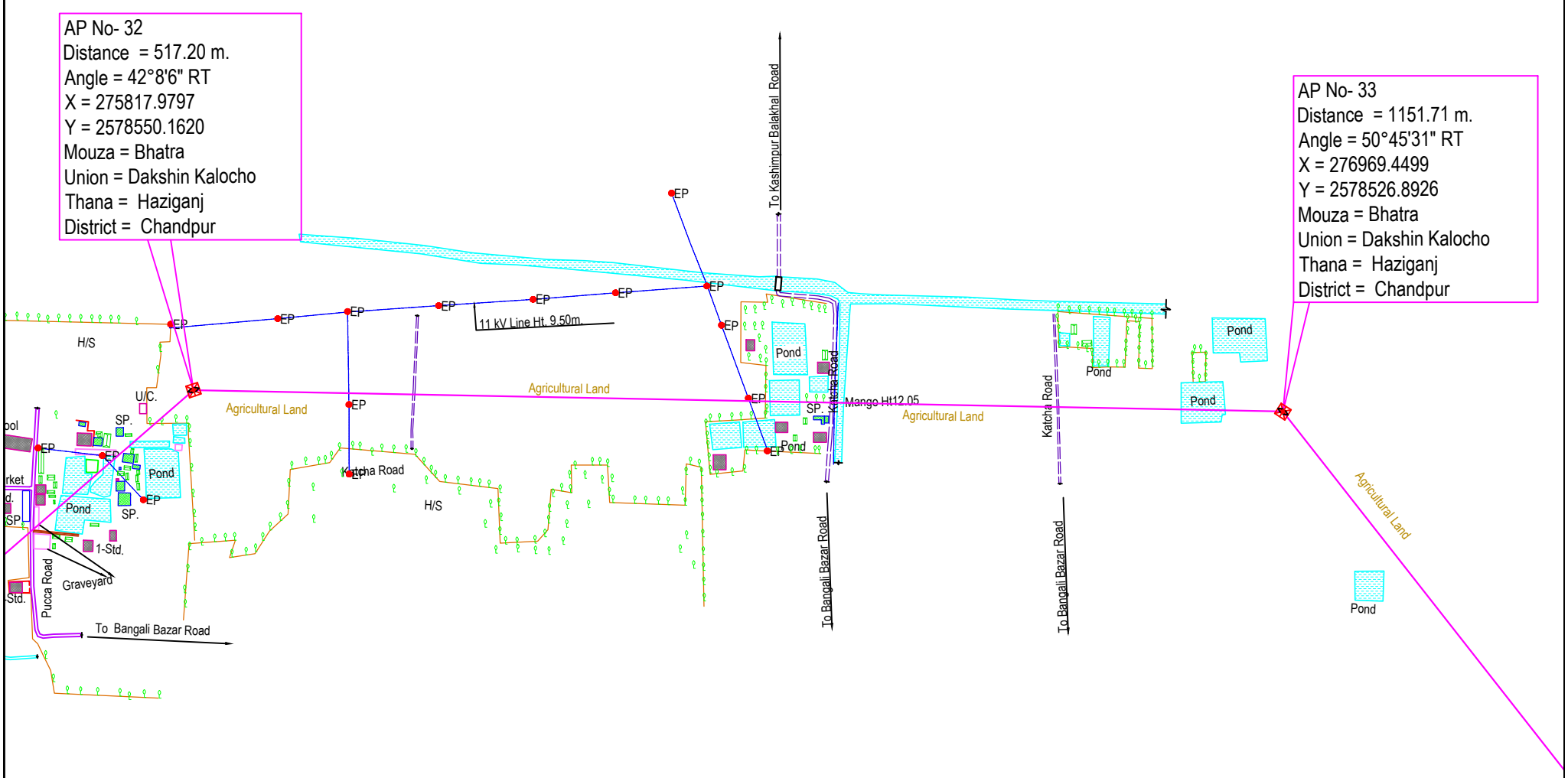
N
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LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	..... EP EP
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	..... MH
Tree/Banana/Bamboo	.....	Railway Line	.....

AP No- 32
Distance = 517.20 m.
Angle = 42°8'6" RT
X = 275817.9797
Y = 2578550.1620
Mouza = Bhatra
Union = Dakshin Kalocho
Thana = Haziganj
District = Chandpur

AP No- 33
Distance = 1151.71 m.
Angle = 50°45'31" RT
X = 276969.4499
Y = 2578526.8926
Mouza = Bhatra
Union = Dakshin Kalocho
Thana = Haziganj
District = Chandpur



CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	19

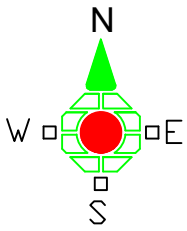
0 m 60 120 180 240 300
Scale :

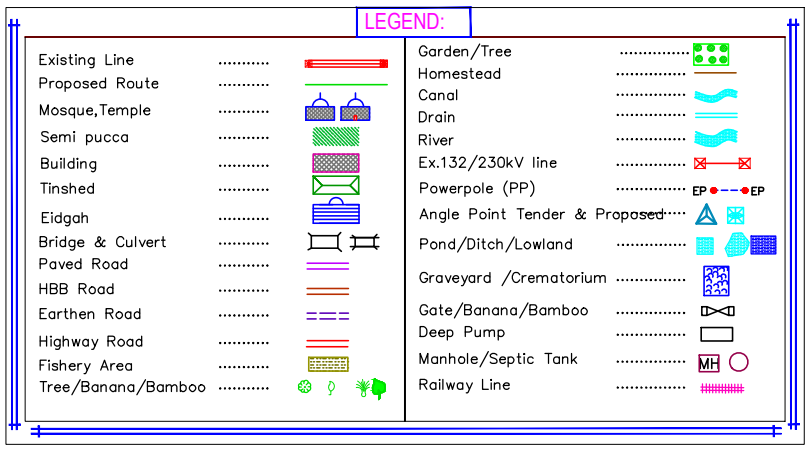
EXISTING PHYSICAL FEATURES SURVEY

132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT

Kachua-Matlab(N)132kV Double Circuit Transmission Line.

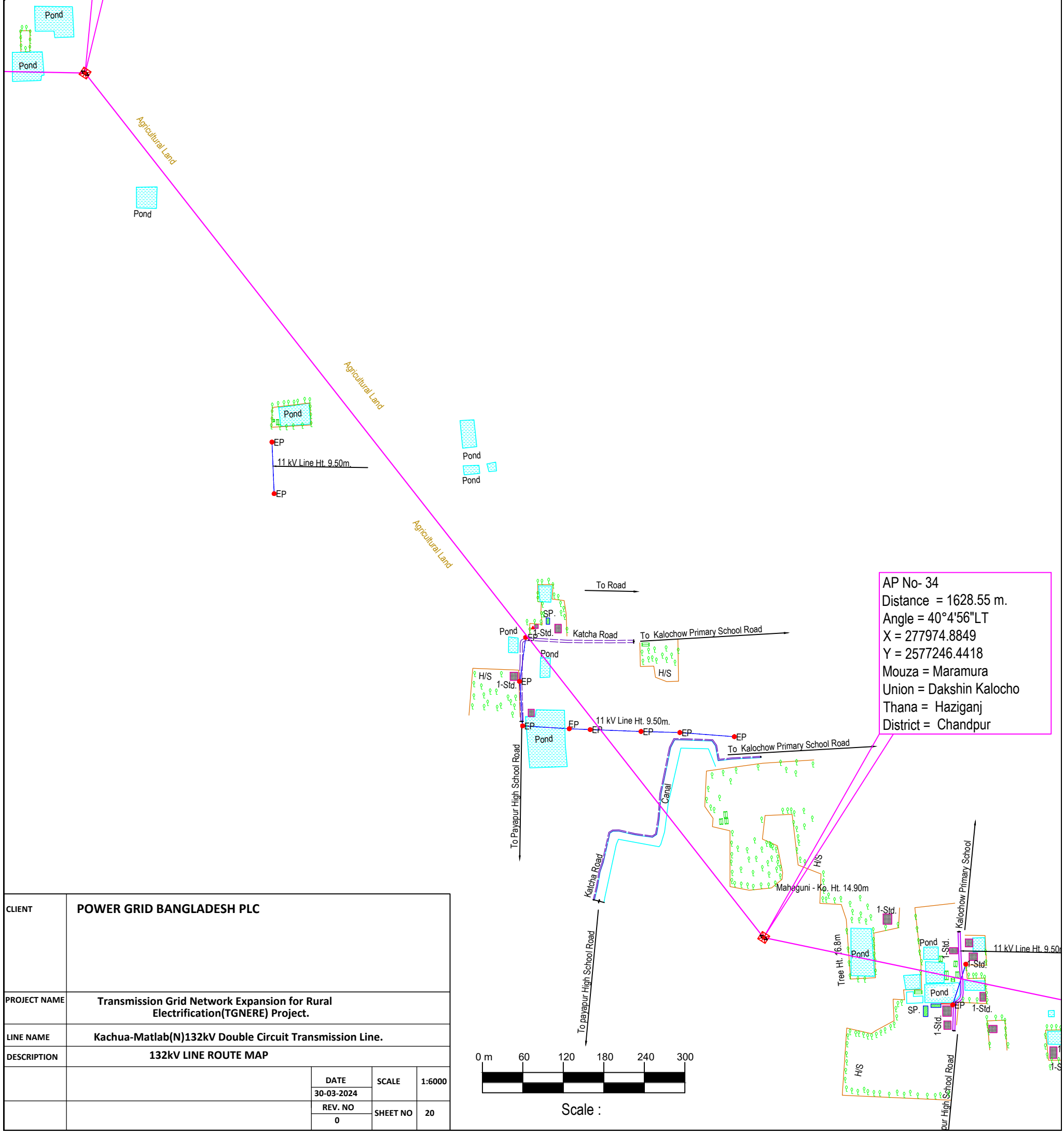
Proposed Route Total Length = 32812.504m.





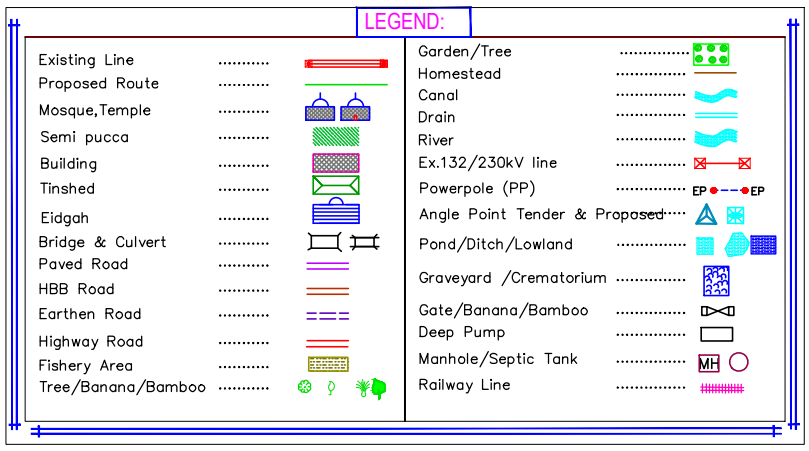
AP No- 33
Distance = 1151.71 m.
Angle = 50°45'31" RT
X = 276969.4499
Y = 2578526.8926
Mouza = Bhatra
Union = Dakshin Kalocho
Thana = Haziganj
District = Chandpur

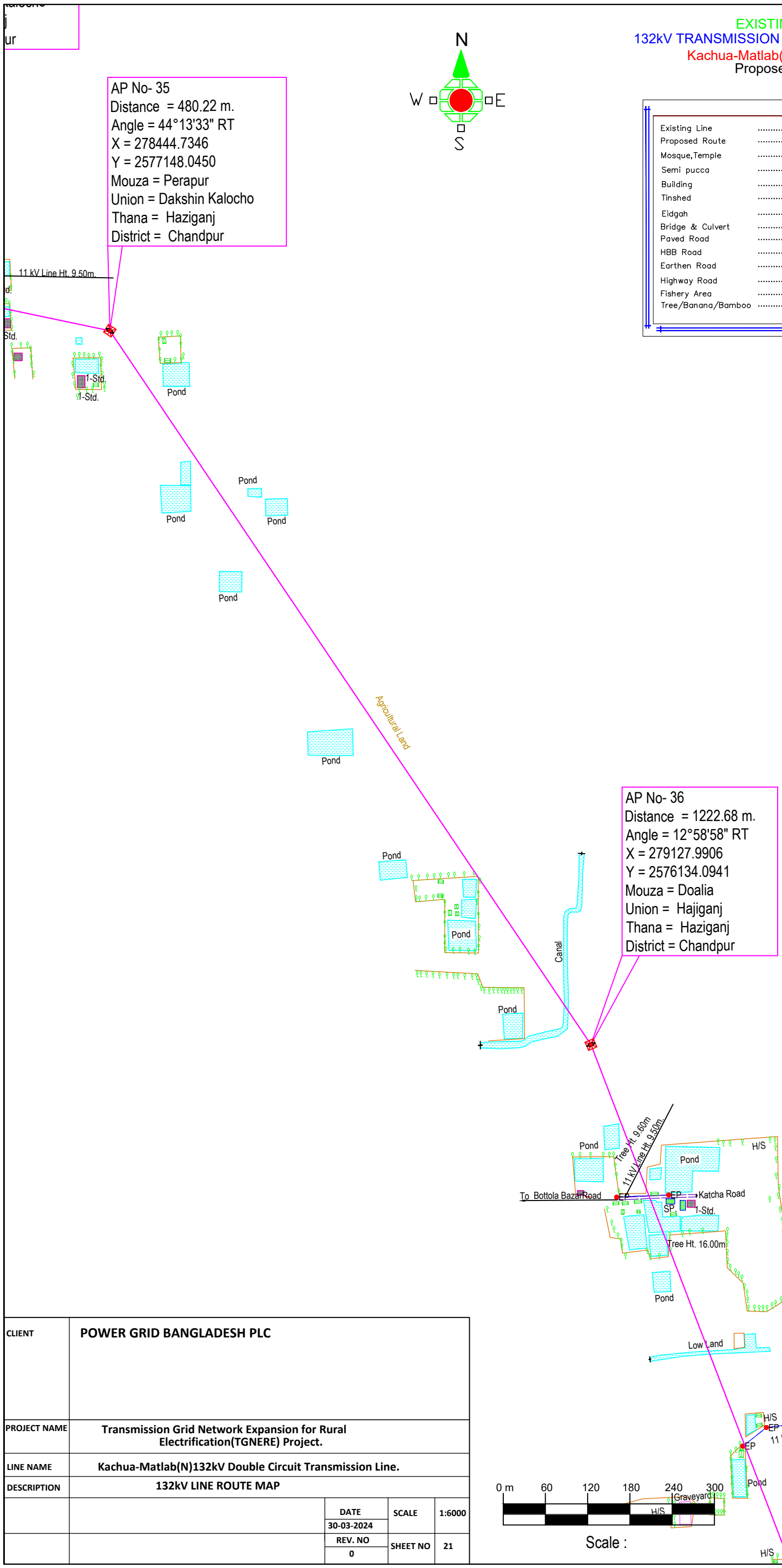
AP No- 34
Distance = 1628.55 m.
Angle = 40°4'56"LT
X = 277974.8849
Y = 2577246.4418
Mouza = Maramura
Union = Dakshin Kalocho
Thana = Haziganj
District = Chandpur



CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	20

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.





CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	21

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
Kachua-Matlab(N)132kV Double Circuit Transmission Line.
Proposed Route Total Length = 32812.504m.

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LEGEND:

Existing Line	Garden/Tree
Proposed Route	Homestead
Mosque,Temple	Canal
Semi pucca	Drain
Building	River
Tinshed	Ex.132/230kV line
Eidgah	Powerpole (PP)
Bridge & Culvert	Angle Point Tender & Proposed
Paved Road	Pond/Ditch/Lowland
HBB Road	Graveyard /Crematorium
Earthen Road	Gate/Banana/Bamboo
Highway Road	Deep Pump
Fishery Area	Manhole/Septic Tank
Tree/Banana/Bamboo	Railway Line

AP No- 36
Distance = 1222.68 m.
Angle = 12°58'58" RT
X = 279127.9906
Y = 2576134.0941
Mouza = Doalia
Union = Hajiganj
Thana = Haziganj
District = Chandpur

AP No- 37
Distance = 923.71 m.
Angle = 47°7'14" LT
X = 279458.7499
Y = 2575271.7499
Mouza = Matain
Union = Hajiganj
Thana = Haziganj
District = Chandpur

AP No-38
Distance = 520.92 m.
Angle = 23°54'17"LT
X = 279942.2159
Y = 2575077.3869
Mouza = Badda
Union = Hajiganj
Thana = Haziganj
District = Chandpur

AP No- 39
Distance = 401.87 m.
Angle = 12°47'40"RT
X = 280343.7771
Y = 2575091.5310
Mouza = Kazirgaon
Union = Hajiganj
Thana = Haziganj
District = Chandpur

CLIENT	POWER GRID BANGLADESH PLC
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.
DESCRIPTION	132kV LINE ROUTE MAP

DATE	SCALE	1:6000
30-03-2024		
REV. NO	SHEET NO	22
0		

0 m 60 120 180 240 300
Scale :

EXISTING PHYSICAL FEATURES SURVEY

132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT

Kachua-Matlab(N)132kV Double Circuit Transmission Line.

Proposed Route Total Length = 32812.504m.

N W E S

LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	..... EP EP
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	..... MH
Tree/Banana/Bamboo	.....	Railway Line	.....

AP No- 40
Distance = 804.09m.
Angle = 42°37'5"RT
X = 281133.6705
Y = 2574941.1248
Mouza = Kajirgaon
Union = Hajiganj
Thana = Haziganj
District = Chandpur

AP No- 41
Distance = 163.87m.
Angle = 9°8'6" RT
X = 281231.3754
Y = 2574809.5709
Mouza = Kajirgaon
Union = Hajiganj
Thana = Haziganj
District = Chandpur

TT No-2
Distance = 342.53m.
Angle = 68°27'12"LT
X = 281389.3578
Y = 2574505.6502
Mouza = Kajirgaon
Union = Hajiganj
Thana = Haziganj
District = Chandpur

Proposed Gantry
Distance = 100.00m.
X = 281488.8246
Y = 2574515.963

To Hajigonj Road
11 kV Line Ht. 9.50m.
2-Std.
Graveyard
Mosque
SP.
Ditch
Agricultural Land
1-Std.
Pond
H/S
EP
11 kV Line Ht. 9.50m.
To Kachua Road
Katcha Road
Garden
Erathen Road
33kV Ht. 12.13 m.
Haziganj 230/132 kV GIS Substation
Canal
Haziganj - Chowmuhuni 230kV TL
33kV Ht. 10.63
Hazigonj - Dhaka District Highway
Bridge
To Hazigonj

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Transmission Grid Network Expansion for Rural Electrification(TGNERE) Project.			
LINE NAME	Kachua-Matlab(N)132kV Double Circuit Transmission Line.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE	SCALE	1:6000
		30-03-2024		
		REV. NO	SHEET NO	23
		0		

0 m 60 120 180 240 300

Scale :

CLIENT : **POWER GRID BANGLADESH PLC**

PROJECT NAME: **Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.**

LINE NAME : LILO of Chowmuhani- Ramganj 132kV Double Circuit Line at Chatkhil.

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
LILO of Chowmuhani- Ramganj 132kV Double Circuit Transmission Line.
Proposed Route Total Length = 1665.905m.

LEGEND:

Existing Line		Garden/Tree	
Proposed Route		Homestead	
Mosque,Temple		Canal	
Semi pucca		Drain	
Building		River	
Tinshed		Ex.132/230kV line	
Eidgah		Powerpole (PP)	
Bridge & Culvert		Angle Point Tender & Proposed	
Paved Road		Pond/Ditch/Lowland	
HBB Road		Graveyard /Crematorium	
Earthen Road		Gate/Banana/Bamboo	
Highway Road		Deep Pump	
Fishery Area		Manhole/Septic Tank	
Tree/Banana/Bamboo		Railway Line	

Tower No. - 46
X = 301909.853
Y = 2550520.269
OPG Height - 32.560m
Top Wire Ht. - 26.521m
Middle Wire Ht. - 21.962m
Bottom Wire Ht. - 17.470m

Tower No. - 45
X = 301909.853
Y = 2550520.269
OPG Height - 33.081m
Top Wire Ht. - 25.092m
Middle Wire Ht. - 20.549m
Bottom Wire Ht. - 16.063m

Tower No. - 44
X = 302028.658
Y = 2550267.232
OPG Height - 33.215m
Top Wire Ht. - 26.677m
Middle Wire Ht. - 22.119m
Bottom Wire Ht. - 17.573m

AP No - 02
Distance = 95.86m.
Angle = 62°19'46"LT
X = 302069.573
Y = 2550181.711
Mouza = Borpit
Union = Nadana
Thana = Sonaimuri
District = Noakhali

AP No - 03
Distance = 72.45m.
Angle = 21°09'24"LT
X = 302139.526
Y = 2550179.142
Mouza = Borpit
Union = Nadana
Thana = Sonaimuri
District = Noakhali

AP No - 01
Distance = 134.38m.
Angle = 58°50'07"LT
X = 302099.783
Y = 2550118.566
Mouza = Borpit
Union = Nadana
Thana = Sonaimuri
District = Noakhali

Tower No. - 43
X = 302157.778
Y = 2549997.342
OPG Height - 33.215m
Top Wire Ht. - 26.202m
Middle Wire Ht. - 21.758m
Bottom Wire Ht. - 17.125m

Tower No. - 42
X = 302293.478
Y = 2549708.902
OPG Height - 33.458m
Top Wire Ht. - 26.525m
Middle Wire Ht. - 22.268m
Bottom Wire Ht. - 17.421m

TT
Distance = 1471.80m.
X = 303328.772
Y = 2551040.932
Mouza = Kaluai
Union = Nadana
Thana = Sonaimuri
District = Noakhali

Proposed Chatkhil Sub-station

N
W E
S

0m 30 60 90 120 150
Scale :

CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	LILO of Chowmuhani- Ramganj 132kV Double Circuit Line at Chatkhil.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	1

CLIENT : **POWER GRID BANGLADESH PLC**

PROJECT NAME: **Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.**

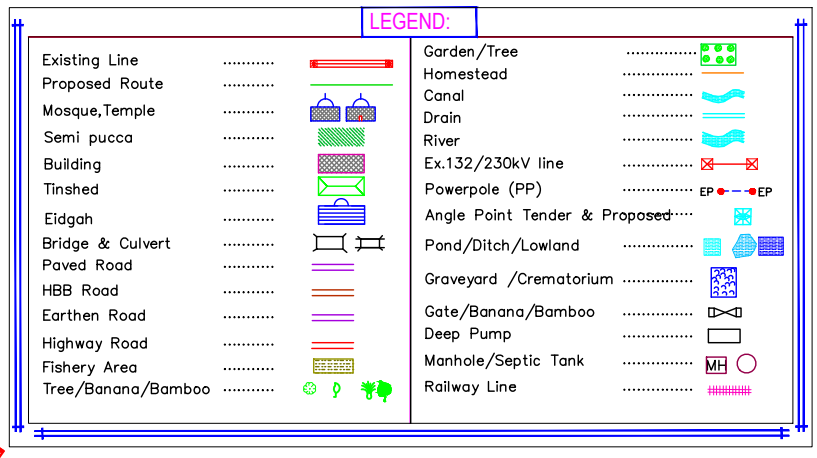
LINE NAME : LILO of Shahjibazar - Brahmanbaria 132kV double circuit line at Madhabpur.

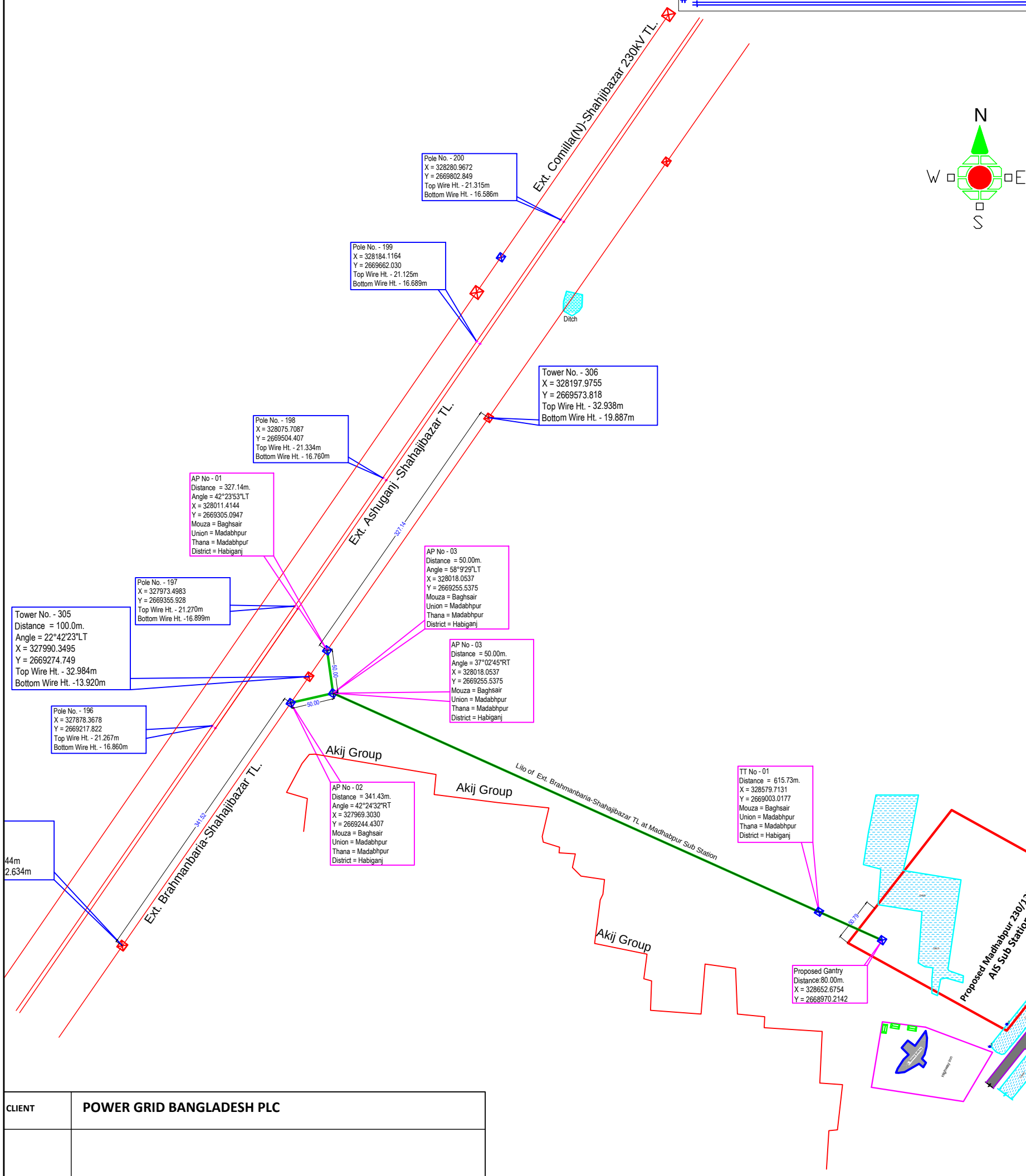
EXISTING PHYSICAL FEATURES SURVEY

132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT

LILO of Shahjibazar - Brahmanbaria132kV double circuit line at Madhabpur.

Proposed Route Total Length = 1414.00m.





CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	LILO of Shahjibazar - Brahmanbaria 132kV double circuit line at Madhabpur .			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE	SCALE	1:6000
		30-03-2024		
		REV. NO	SHEET NO	1
		0		

CLIENT : **POWER GRID BANGLADESH PLC**

PROJECT NAME: **Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.**

LINE NAME : LILO of Bogura(S) - Naogaon 132kV line at Dupchanchia.

EXISTING PHYSICAL FEATURES SURVEY

132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT

LILO of Bogura(S) - Naogaon 132kV line at Dupchanchia.

Proposed Route Total Length = 1875.200m.

LEGEND:

Existing Line	.....	Garden/Tree	.....
Proposed Route	.....	Homestead	.....
Mosque,Temple	.....	Canal	.....
Semi pucca	.....	Drain	.....
Building	.....	River	.....
Tinshed	.....	Ex.132/230kV line	.....
Eidgah	.....	Powerpole (PP)	..... EP EP
Bridge & Culvert	.....	Angle Point Tender & Proposed	.....
Paved Road	.....	Pond/Ditch/Lowland	.....
HBB Road	.....	Graveyard /Crematorium	.....
Earthen Road	.....	Gate/Banana/Bamboo	.....
Highway Road	.....	Deep Pump	.....
Fishery Area	.....	Manhole/Septic Tank	..... MH
Tree/Banana/Bamboo	.....	Railway Line	.....

N

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TT No - 01
Distance = 649.23m.
Angle = 61°11'42"LT
X = 718064.4144
Y = 2754649.198

Proposed Dupchanchia Sub Station

Earthen Road

Homestead

Pond

Pond

AP No - 01
Distance = 972.14m.
Angle = 24°34'17"LT
X = 718345.7000
Y = 2754064.070

Ditch

Ditch

Garden

Garden

Pucca Road

Pond

Ditch

Ditch

Garden

Pond

Homestead

Pond

AP No - 02
Distance = 350.52m.
Angle = 44°36'24"RT
X = 719093.0705
Y = 2753442.3838

Tower No. - 65
X = 719242.2400
Y = 2753318.300
OPG Height - 31.750m
Top Wire Ht. - 24.177m
Middle Wire Ht. - 19.939m
Bottom Wire Ht. - 15.607m

1-Std.

Shed

Ditch

1-Std.

1-Std.

D

Ditch

Chatal

Ext. Bogura Naogaon 132kV TL.

1-Std.

1-Std.

1-Std.

Shed

1-Std.

1-Std.

2-Std.

1-Std.

Homestead

Pucca Road

Pucca Road

Tower No. - 64
X = 719527.5400
Y = 2753381.400
OPG Height - 30.342m
Top Wire Ht. - 24.193
Middle Wire Ht. - 19.94
Bottom Wire Ht. - 15.7

AP No - 03
X = 719127.5104
Y = 2753093.5648

1-Std.

Shed

Homestead

1-Std.

Pond

Mosque

1-Std.

1-Std.

1-Std.

Homestead

AP No - 05
X = 719182.2218
Y = 2753119.6087

AP No - 04
X = 719153.8195
Y = 2753025.5826

1-Std.

Tower No. - 66
X = 719157.5100
Y = 2753037.800
OPG Height - 34.240m
Top Wire Ht. - 27.847m
Middle Wire Ht. - 23.658m
Bottom Wire Ht. - 19.436m

0 m 30 60 90 120 150

Scale :

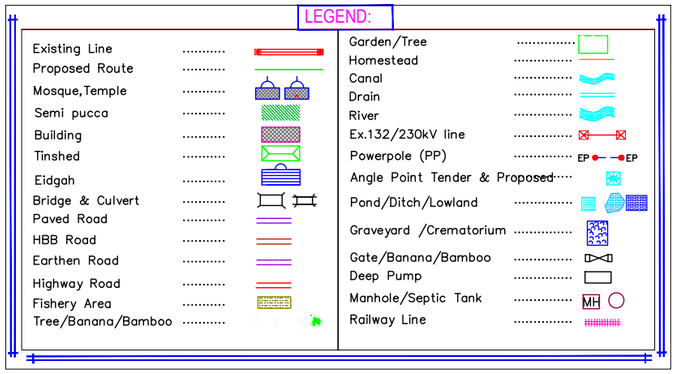
CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	LILO of Bogura(S) - Naogaon 132kV line at Dupchanchia.			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	1

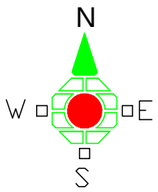
CLIENT : **POWER GRID BANGLADESH PLC**

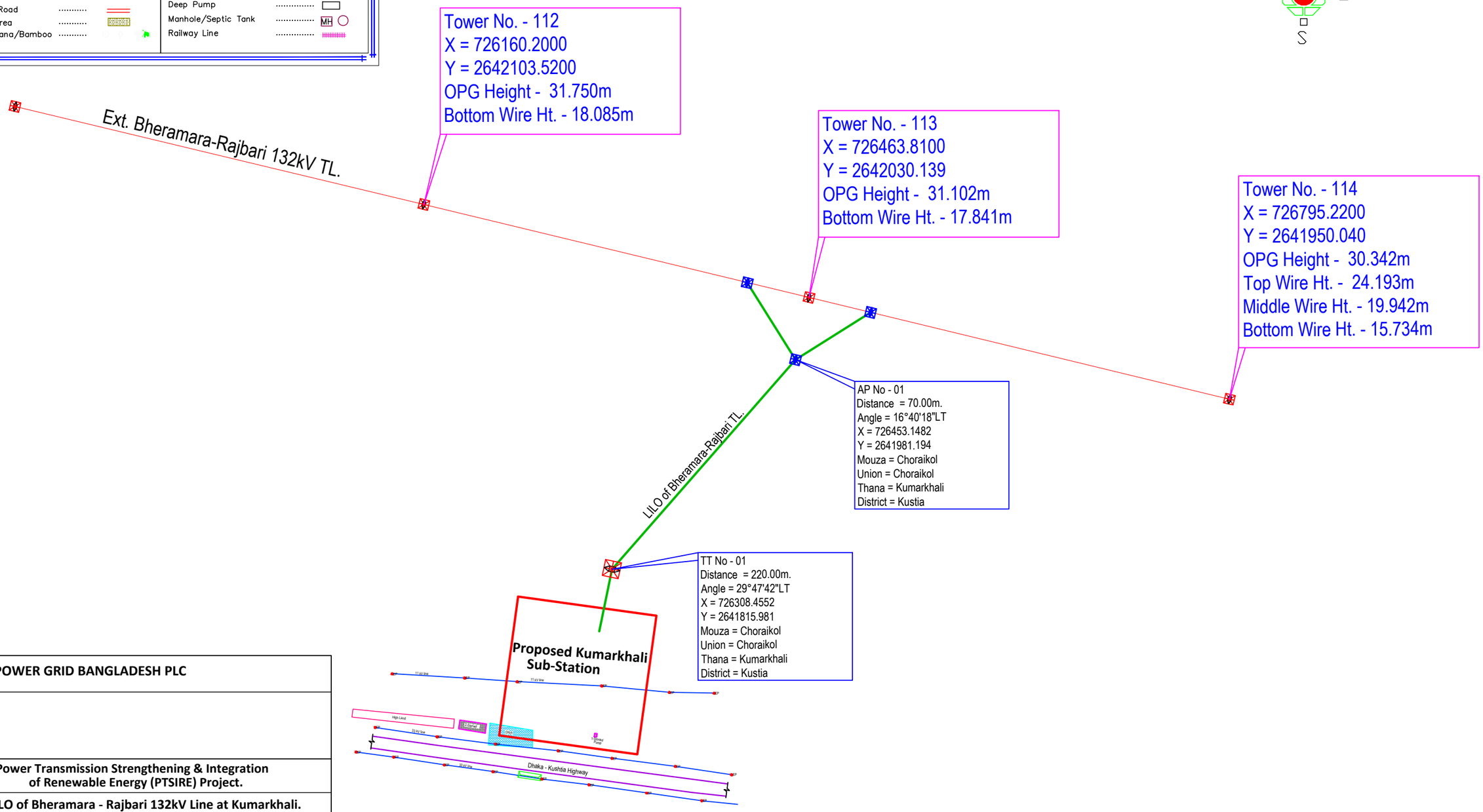
PROJECT NAME: **Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.**

LINE NAME : LILO of Bheramara - Rajbari 132kV Line at Kumarkhali.

EXISTING PHYSICAL FEATURES SURVEY
132kV TRANSMISSION LINE SURVEY BY DIGITAL SURVEY EQUIPMENT
LILO of Bheramara - Rajbari 132kV Line at Kushtia.
Proposed Route Total Length = 411.08m.





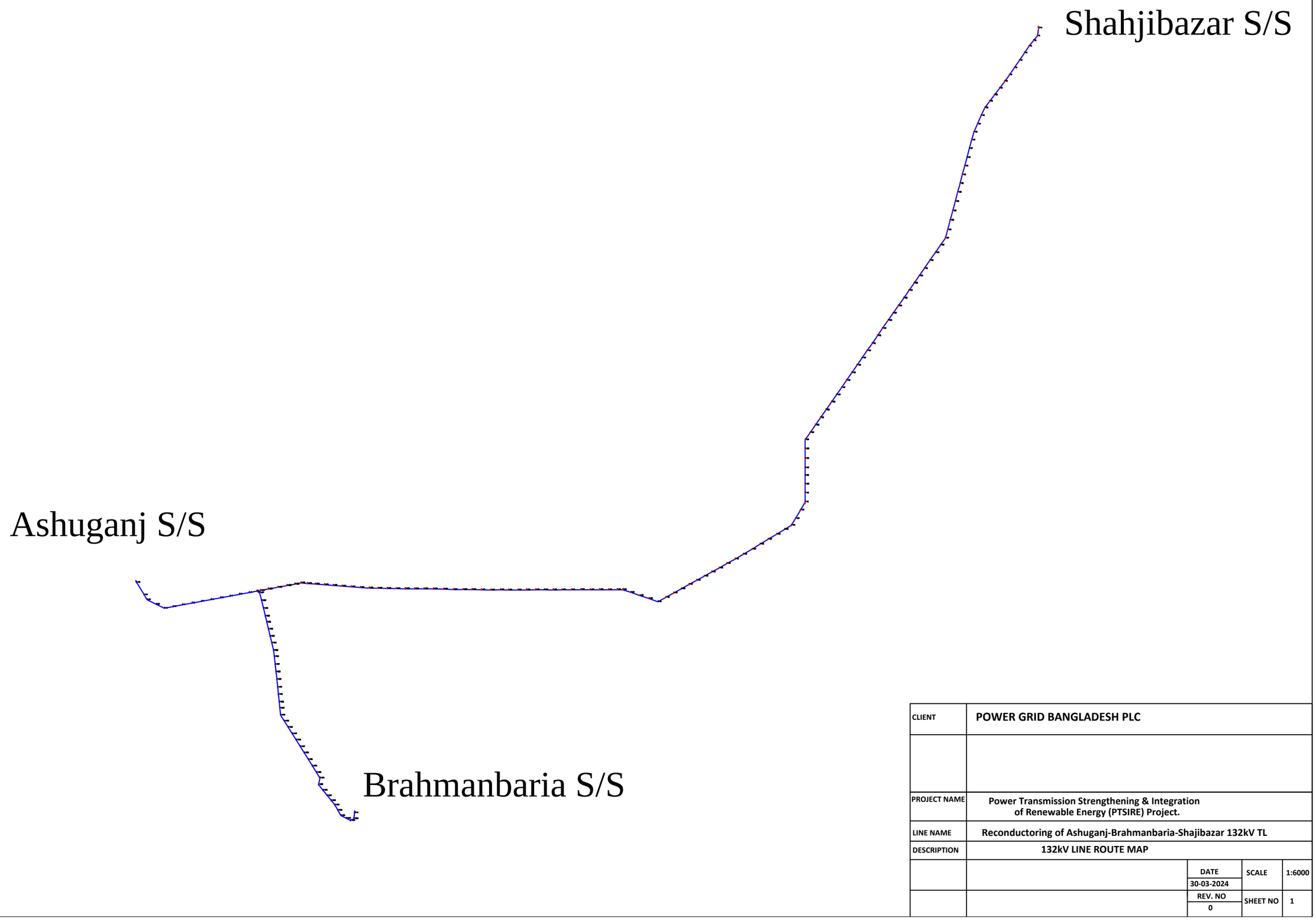


CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	LILO of Bheramara - Rajbari 132kV Line at Kumarkhali.			
DESCRIPTION	132 kV LINE ROUTE MAP			
		DATE	SCALE	1:3000
		30-03-2024		
		REV. NO	SHEET NO	1
		0		

CLIENT : **POWER GRID BANGLADESH PLC**

PROJECT NAME: **Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.**

LINE NAME : Reconductoring of Ashuganj-Brahmanbaria-Shajibazar 132kV TL



CLIENT	POWER GRID BANGLADESH PLC			
PROJECT NAME	Power Transmission Strengthening & Integration of Renewable Energy (PTSIRE) Project.			
LINE NAME	Reconductoring of Ashuganj-Brahmanbaria-Shajibazar 132kV TL			
DESCRIPTION	132kV LINE ROUTE MAP			
		DATE 30-03-2024	SCALE	1:6000
		REV. NO 0	SHEET NO	1