# Terms of Reference

# Upper Arun Hydroelectric Limited

**(A subsidiary company of Nepal Electricity Authority)**

# TERMS OF REFERENCE

## For the

## Geological expert

## for the

## Upper Arun Hydroelectric Project

| | |
|---|---|
| **Project** | **: Project Preparatory Fund (PPF)-P178722** |
| **Credit No.** | **: IDA V501-NP** |
| **Ref. No.** | : PPF/ UAHEL/S/IND-9 (Geological expert) |
| **Assignment** | **: To support Upper Arun Hydroelectric Limited in Geological and Geotechnical matters** |

**September, 2024**

# Table of Contents

**Acronyms**

| | |
|---|---|
| CSPDR | Changjiang Survey, Planning, Design and Research Company Limited |
| DNP | Defect Notification Period |
| DoED | Department of Electricity Development |
| IKHPP | Ikhuwa Khola Hydropower Project |
| HIDCL | Hydroelectricity Investment and Development Company Limited |
| MoEWRI | Ministry of Energy, Water Resources and Irrigation |
| NEA | Nepal Electricity Authority |
| SRCL | Soil Rock and Concrete Laboratory |
| UAHEL | Upper Arun Hydroelectric Limited |
| UAHEP | Upper Arun Hydroelectric Project |
| UFSR | Updated Feasibility Study Report |

# 1 BACKGROUND

The World Bank is providing financial support to the Government of Nepal, Ministry of Energy, through the Nepal Electricity Authority (NEA), to carry out Environmental and Social Assessment, Tender Design, Preparation of Bidding Document, Construction Supervision and Post Construction Services for the Upper Arun Hydroelectric Project (UAHEP).

The proposed UAHEP project site was first identified by the Master Plan Study of Koshi River Water Resources Development by JICA in 1985. A subsequent reconnaissance study was conducted by NEA in the summer of 1986. In 1991, a feasibility study of the project was completed on behalf of NEA by a Joint Venture of Morrison Knudsen Corporation, Lahmeyer International, Tokyo Electric Power Services Co., and NEPECON. A preliminary Environmental Assessment was also carried out. NEA had intended to develop the UAHEP only well after completion of the Arun III Hydropower Project. The two projects are not interdependent, and no specific sequencing is required to ensure the viability of each. After failing to achieve financial closure on Arun III, NEA shifted focus to the development of other hydropower projects outside the Arun Valley. In 2011, in order to meet increasing electricity demands and mitigate load shedding, NEA revisited and reviewed the feasibility study of UAHEP and re-affirmed it as a priority project due to its relatively low cost of generation, its availability of high firm energy and potential to contribute to the Integrated Nepal Power System, and its location in the power deficient eastern region of Nepal. The review also identified changes in available infrastructure at and around the project site and collected additional information contributing towards the detailed engineering design of the project. In February 2013, a cabinet decision granted the NEA permission to implement the UAHEP under the ownership of the Government of Nepal (GoN). Government of Nepal issued survey license for the project to Upper Arun Hydroelectric Limited with installed capacity as 1061 MW on 2076/5/25 (September 11, 2019), which was later issued with installed capacity as 1063.36 MW on 2080/03/13 (June 28, 2023) including eco-flow turbine of 2.36 MW. Besides, GoN has also decided to develop Ikhuwa Khola Hydropower Poject (IKHPP) under UAHEL.

The study of UAHEP (UFSR and Environmental and Social Study) was carried out with the financial assistance of World Bank (WB) under Power Sector Reform and Sustainable Development Hydropower Projects (PSRSHDP). The World Bank provided a credit of US$ 13.1 million on the proposed credit number 5728-NP for the preparation of Upper Arun and Ikhuwa Khola Hydroelectric Projects. The credit was sub-lent to Nepal Electricity Authority (NEA) as a subsidiary loan under the subsidiary loan agreement between GoN and NEA. The World Bank phased out the PSRSDHP on December 30, 2022, but study work has not been finished yet. So, as preparation of the project for implementation, the World Bank has now provided the financial assistance under the Project Preparation Facility (PPF) a credit of US$ 6 million.

The project is assumed to be financed by a combination of debt and equity in approximately 80-20 ratio. Minutes of Understanding (MoU) signing was held on 15th September, 2022, with consortium of domestic financiers led by HIDCL (NPR. 53.341 Billion). The World Bank is

leading the debt financing with support from other International Development Partners (IDP). IDPs include the World Bank Group (WBG), JICA, EIB, SFD, OFID, and ADB. The loans from WB and other international Development partners will be a sovereign loan to GON which will be on lent to NEA and denominated in dollars. NEA will on lend to the Company in Nepalese Rupees.

After completion of the updated feasibility studies of UAHEP and IKHPP, the contract with previous Consultant (JV of CSPDR and Sinotech Engineering) was terminated in November 2021. The contract for Owner's Engineer (OE) has been signed with JV of TRACTEBEL ENGINEERING GmbH, Germany (Lead firm), TRACTEBEL ENGINEERING S.A., France and WAPCOS LIMITED, India on February 14, 2024 and the Contract has been made effective from March 25, 2024. The OE will carry out the tender design and biding documents for UAHEP and assist the Upper Arun Hydroelectric Limited (herein after the Client) to procure contractors for the construction of the project under phase A, i.e. Tender Design, Tender Document Preparation and assist in Bid Evaluation. The same consultant will also perform the downstream activities of construction supervision, contract management and the post construction service under Phase B&C.

UAHEL has made agreement with Dam Safety Panel of Experts (DSPoE) and Environment and Social Panel of Experts (ESPoE) to carry out the independent technical review of the deliverables submitted by the OE.

Environmental and Social Impacts Assessment (ESIA), Cumulative Impact Assessment (CIA), Critical Habitat Assessment, E-flow management plan and social planning studies of the project were conducted following the Environmental and Social Standards of Environmental and Social Framework 2016 in financial assistance of World Bank.

At present, the Construction of the Project Access Road of 21.19 km including 2.03 km of Road Tunnel and about 70 m of the Steel Truss Bridge is on-going. Similarly, the construction of the employer's camp Phase-I is also in progress.

Now, UAHEL is planning to hire the experts for supporting the UAHEL team in technical, project monitoring, contract management, legal, environmental and social aspects of the project design and implementation.

## 2 PROJECT DESCRIPTION

The project components to be covered under the Tender Design, Preparation of Bidding Document, Construction Supervision and Post Construction Services for the Upper Arun Hydroelectric Project, include various ancillary activities related to each hydroelectric component, and the required project roads and transmission line from the powerhouses of UAHEP to the proposed substation of at Haitar (Arun Hub). These are described below and referred to collectively thereafter as "the Project," unless otherwise specified.

**Upper Arun Hydroelectric Project (UAHEP)**

The UAHEP is located in Koshi Province, Sankhuwasabha District, Bhotkhola Rural Municipality of the eastern Nepal. The project area is situated within Longitude 87$^0$20'00" to 87$^0$30'00" East and Latitude 27$^0$38'24" to 27$^0$48'09" North, about 15 km south of the international border with Tibet and 220 km east of Kathmandu. The proposed dam site is located in the Chepuwa Village, in a narrow gorge about 350 m upstream of the Arun River's confluence with the Chepuwa River. The proposed power plant site is located at Chhongrak of Hatiya Village, 16 km downstream of the dam site, near the Arun River's confluence with the Leksuwa River. The right bank of the Arun River at the proposed UAHEP site falls within the Makalu Barun Buffer Zone, which is adjacent to the Makalu Barun National Park. The proposed UAHEP dam site is therefore located at the edge of the Buffer Zone.

As per UFSR 2021, the nominal installed capacity of 1,040 MW, with rated capacity of about 1,061 MW with the addition of 2.36 MW for environmental flow turbine at the dam toe, the rated capacity has been finalized as 1,063.36 MW. The proposed UAHEP is designed to be a Peaking Run-of-River (PRoR) project with RCC Dam across the Arun River. Intakes on the left bank of the river are proposed to divert the design discharge of 235.44 $m^3/s$ through an intake tunnel to a headrace tunnel of 8.36 km, surge tank, drop shaft, pressure tunnel, and ultimately to the underground powerhouse for power generation. After power generation, water will be released back to the Arun River.

For the power evacuation of UAHEP, a 400 kV double circuit transmission line shall be constructed from the powerhouse to a proposed substation at Haitar. Total length of the proposed transmission line is about 6 km. The salient features of the proposed project as recommended by the Updated Feasibility Study Report (UFSR) are listed in Annex A.

## 3 OBJECTIVES

The primary objective is to engage experienced experts across various disciplines to successfully develop and execute the project. Specifically, the objectives include:

- To ensure the project is technically and economically sound through a compressive design review and monitoring process.
- To implement a well-organized and controlled project execution plan that meets deadlines, budget, and quality standards.
- To negotiate, manage and administer contracts with various vendors and service providers throughout the project lifecycle.
- To ensure the project adheres to all relevant environmental regulations and minimizes ecological impact.
- To deliver a fully functional hydropower plant that meets the client's objectives for power generation and sustainability.
- To coordinate with different stakeholders during execution of the project.

By bringing together the diverse specialists, the client aims to achieve a well-rounded approach to hydropower project development i.e. well blending of time, cost and quality in the project development.

## 4 SCOPE OF SERVICES

The Geological expert, a national expert with international experience, will provide full time support during crucial phase of the project: tender design, tender document preparation and contract negotiation. The expert's main task would be as follows but not limited to:

- Review available geological and geotechnical data and reports for the project site.
- Review and supervise the field investigations conducted, including geophysical surveys, drilling, and soil sampling, to characterize subsurface conditions.
- Evaluate soil and rock condition at project sites through the review of geotechnical reports, in-situ and laboratory tests and geological data and assess the needs for additional investigation and tests.
- Plan geotechnical laboratory testing programs and analyse laboratory test results to determine soil properties, rock strength, and other relevant parameters.
- Review the engineering reports, plans, maps, charts, diagrams and specifications prepared by the Consultant.
- Assist the Project in Geological Mapping in Tunnel/Project Sites including Logging of Tunnels.
- Review the site assessments conducted to determine appropriate location for structures/foundations.
- Review the quality and adequacy of construction materials based on the results of site investigations and tests at quarries and borrow areas.
- Assess geohazards, such as landslides, slope failure, etc., in the reservoir and catchment areas of the dam.
- Ensure that the site investigation results are accurately incorporated into project design.
- Ensure the application of the international geotechnical standards and good practices to guide in the implementation and performance of the various infrastructural works.
- Provide expert advice on geotechnical engineering principles, and geologically, and seismic considerations relevant to the project.
- Review and endorse all reports related to geology and geotechnical investigations to be submitted to WB to ensure quality submissions.
- Review and assist in preparation of comprehensive Geotechnical Baseline Report (GBR) and Geotechnical Data Report (GDR), the Employer's Risk Register and Risk Management Plan, etc., based on the available site investigation and test data in coordination with the World Bank, GBR expert and DSPOE.
- Review the GBR submitted based on the Draft table of contents of the GBR (Annex….), a part of ToR for Owner's Engineer.
- Review the adequacy of the geotechnical investigation for the foundation and for material sources including results of drilling or boring, laboratory testing, in-situ tests and regional and local geological characteristic necessary to prepare the Geotechnical Baseline Report (GBR) and Geotechnical Data Report (GDR).

- Review the Schedules of Baselines, Completion Schedules, Bills of Quantities and reference information. Reference information shall be compiled and will include studies and investigation documents as may be relevant to bidders for their bid.
- Review of GBR in the bid documents based on corresponding Standard Procurement Documents of the World Bank, i.e., FIDIC contracts including Emerald Book 2019.
- Examine tender design and documents prepared by consultant to ensure the adequacy and compliance with international geotechnical standards, requirements, and good practice.
- Identify and assess any geotechnical issues, risks, or uncertainties and mitigation measures in project plans and designs.
- Assist UAHEL with the examination of the bids, including the requesting of any clarifications needed for the evaluation and comparison of the bids.
- Provide support to UAHEL during the implementation of the GBR.
- Inspect proposed construction site and set up test equipment and drilling machinery.
- Assist in supervision of tunnel construction including excavation, drilling, blasting, mucking and support works.
- Assist in supervision and monitoring of the underground/ surface construction work as per the drawing, BOQ and specification.
- Review and assist in the update of the underground/ surface construction schedule including weekly, monthly, and yearly plans.
- Coordinate with the Consultant as per requirement to ensure construction quality including time and cost control.
- Ensure reliability of progress report submitted by the Consultant/ Contractor.
- Supervise on resolution of the contractual issues arising with respect to the underground investigation during construction.
- Document findings, interpretations, and recommendations.
- Present findings to project stakeholders and address any queries or concerns.
- Work in close coordination with the Dam Safety Panel of Experts (DSPOE)

The Expert is required to attend meetings and field visits in weekends and holidays, if requested by the Employer.

## 5 EXPERT'S QUALIFICATION AND EXPERIENCES

The expert must have Master's degree in Geotechnical Engineering/Engineering Geology or a related field with 20 years of experience. The expert must have minimum 10 years of experience on at least two hydropower projects

The expert must have extensive experience in conducting geotechnical investigations for hydropower projects or similar infrastructure projects.

S/he should have proficiency in interpreting GBR, GDR, geological and geotechnical data and providing practical recommendations.

The expert must have proven experience in preparation and implementation of GBR and have excellent understanding of risk identification and mitigation strategies in construction contracts.

He/she must have in-depth knowledge of internationally recognised form of contracts such as the conditions of contract that is available within the Standard Procurement Documents of the World Bank, FIDIC contracts and related guidance documents, as well as modern design practices. The experience in FIDIC Emerald Book 2019 will be an added advantage.

The expert should have practical and technical expertise in carrying out and/or reviewing Engineering Design reports.

S/he shall have strong negotiation, analytical, reporting and communication skills.

The expert should have fluency in both written and spoken English.

The expert should demonstrate experience of working in similar hydropower projects. Working experience in an international environment (outside home country) will be of an added advantage.

## 6 TIMESCHEDULE AND EFFORT LEVEL

The Geological expert will be engaged on a **full-time basis** throughout the project preparation and implementation (Phase A and B) of the project. The specific duration of the expert's input will vary depending on the project stage and evolving needs.

## 7 SELECTION PROCESS

The selection of the individual consultant will be carried out based on method for the "Selection of Individual Consultant" as per the World Bank Procurement Regulations for IPF Borrowers 5th Edition ("Procurement Regulations") following the competitive selection process.

## 8 SERVICES AND FACILITIES BY UAHEL

**Documentation:** UAHEL shall provide all relevant available documents, including reports on previous studies that may be required for the performance of the services.

**Office space/Residence, facilities, and transportation:** Office space and necessary facilities will be provided by the Employer based on the time input of the services.

## 9 REPORTING REQUIREMENTS

The Geological expert will be required to submit reports after each review phase, summarizing:

- Key findings in bidding document or tender design (if applicable).
- Recommendations for revision or clarifications.
- Notes and key points from contract negotiation sessions.

## 10 CONTRACT DURATION

The consultant will be initially engaged for a period of 24 months. Subject to the performance of the consultant, the contract will be renewed for a further period of mutually agreed duration.

The normal working hours will be 8 hours in a day and 40 hours in a week. The consultant will be entitled for holidays as per the prevailing HR Rules of the UAHEL.

## 11 PAYMENT

Remuneration to the Expert will be paid on monthly basis. The Expert shall submit a monthly time sheet giving the details of work carried out by him/her in each working day to the Managing Director of UAHEL for payments

The reimbursable cost during site visit will be paid as per actual.

The consultant will be required to manage his/her own insurance policies and bear the cost of medical treatment. Settlement of the income tax shall also be the sole responsibility of the individual consultant in accordance with the prevailing tax laws in Nepal.

## 12 ANNEXES

**ANNEX A: (i) Salient features of the Upper Arun Hydroelectric Project, as recommended by the Updated Feasibility Study Consultant:**

| ITEM | DESCRIPTION |
|---|---|
| **Location:** | Arun River at Chepuwa Village, Sankhuwasabha District Longitude 87°20'00" to 87°30'00" East and Latitude 27°38'24" to 27°48'09" North |
| **Purpose:** | Electricity generation to fulfill domestic demand; sell surplus to neighbouring countries |
| **Hydrology:** | |
| Drainage area of Arun Basin | 30,400 km² |
| Long-term average flow | 217 $m^3/s$ |
| Average annual runoff | 6.85 billion $m^3$ |
| 10,000-year Flood (Dam site/ Powerhouse site) | 4,870/5,550 $m^3/s$ |
| Probable Maximum Flood (Dam site/ Powerhouse site) | 4,990/6,060 $m^3/s$ |
| Glacial Lake Outburst Flood (GLOF) (Dam site/ Powerhouse site) | 7,576/8,478 (of Lower Barun glacial lake) $m^3/s$ |
| **Sediments:** | |
| Suspended sediment average load | 13.81 x $10^6$ t/yr |
| **Reservoir Characteristics:** | |
| Full supply level (FSL) | 1,640 m |
| Minimum operating level (MOL) | 1,625 m |
| Reservoir volume at FSL | 5.07 million $m^3$ |
| Reservoir volume at MOL | 2.66 million $m^3$ |
| Live storage | 2.41 million $m^3$ |
| **River Diversion during Construction:** | Diversion tunnel, with upstream and downstream cofferdams |
| Design flood (return period) | 257 $m^3/s$ |
| Diameter of diversion tunnel | 7 m×8 m (W×H) |
| Length of diversion tunnel | 490.41 m |
| Cofferdams | Overflow type cofferdams<br>Dry season: for water retention and the diversion tunnel for water release<br>Flood Season: flood flows over the overflow cofferdams and through the diversion tunnel |
| **Dam Characteristics:** | |
| Type | Concrete gravity dam |
| Crest elevation | 1,644 m |
| Crest length | 184 m |
| Maximum height of dam | 91 m |
| **Power Intake:** | |
| Type | Dam intake with a skimming wall |
| Opening size and Number | 6.7 m×8.64 m (W×H) × 1 Pc |

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| Sill level | 1,606.80 m |
| **Spillway:** | |
| Type | a) 3 Low-level outlets<br>Ungated overflow spillway |
| GLOF design discharge | 6,661 $m^3/s$ at low level outlets<br>100 $m^3/s$ at ungated overflow spillway<br>b) (815 $m^3/s$ through Sediment bypass tunnel) |
| **Sediment Bypass Tunnel:** | |
| Type | Free flow tunnel |
| Design discharge capacity | 815 $m^3/s$ |
| Cross section | inverted D-shape with width of 9 m, height of 10.8 ~ 14.0 m |
| Length | 1.4 km |
| **Low Pressure Headrace Tunnel:** | |
| Number | 1 |
| Length | 8,362 m |
| Section net diameter | 8.40 m |
| Lining type | concrete lining |
| Flow velocity | 4.29 m/s |
| **Surge Tank:** | |
| Type | Restricted Orifice with 4.3 m diameter |
| Diameter | 20 m (Inner dia.) |
| Height | 90.5 m |
| **Drop Shaft:** | |
| Diameter | 7.3 m |
| Height | Elevation: 1,095-1,577.8 m |
| **Main Penstock:** | |
| Length | 39 m |
| Diameter | 6 m/2.5 m (Main pipe/branch pipe) |
| Type | Steel lined |
| **Powerhouse:** | |
| Type | underground |
| Dimension | 230.05 m×25.7 m×59.43 m (L×W×H) |
| Installed elevation of turbines | El. 1,095 m |
| Unit bay length | 28.80 m |
| **Electromechanical Equipment:** | |
| Turbine | 6 x @173.33 MW |
| Generator | 6 x @15.75 kV; 213 MVA; 0.85 pf |
| **Transformers:** | 18 Nos. 15.75/400 kV @73 MVA Single phase<br>1 additional stand by |
| **Transmission Facilities:** | |
| Length | 9 Km (to Haitar Substation) |
| Voltage Level | 400 kV |
| **Roads:** | |
| Access road | 23 km (including a 80 m long bridge and a 2 km long tunnel) |
| Project road | 15.2 km |
| **Power and Energy Generation:** | |

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|---|---|
| Installed capacity | 1,040 MW |
| Firm capacity | 697 MW ($Q_{95}$ inflow; 6 h daily peaking) |
| Average annual energy output | 4,512.6 GWh |
| Dry season peak energy | 833.9 GWh |
| Dry season off peak energy | 416.1 GWh |
| Dry season/total energy ratio | 27.7% |
| Wet season peak energy | 956.4 GWh |
| Wet season off-peak energy | 2,306.2 GWh |
| Plant factor | 49.5% |
| **Project Cost Estimate:** | |
| Hydropower complex project | 1,173.03 USD million |
| Transmission line project | 42.17 USD million |
| Powerhouse and headwork connecting traffic project | 47.01 USD million |
| Total static project cost | 1,262.21 USD million |
| **Construction Period:** | |
| Time to first unit in operation | 55 months |
| Total construction period | 60 months |
| **Economic Evaluation:** | |
| Static cost per kW | 1,214 USD/kW |
| Levelized Cost of Energy (LCOE) | 3.5 USc/kWh |
| Net Present Value (NPV) | 835.5 USD million |
| Economic Internal Rate of Return (EIRR) | 17.9% |
| Benefit-Cost Ratio (B/C) | 2.0 |

## Annex B: Summary of Tasks and Reports of Tender Design Consultant for Phase A.

(1) The summary of Tasks to be carried out by the Consultant:

**Upper Arun Hydroelectric Project**

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|---|---|
| Task 1 | Review of Previous Studies, Designs and Documents |
| Task 2 | Building Information Modeling (BIM) |
| Task 3 | Updating of Environmental and Social Management Plan (ESMP) |
| Task 4 | Employer's Reference Design |
| Task 5 | Detailed Engineering Design of Employer's Camp |
| Task 6 | Hydraulic Model Studies |
| Task 7 | Preparation of Prequalification /Initial Selection Documents |
| Task 8 | Preparation of Tender Documents |
| Task 9 | Updating of Construction Schedule and Cost Estimate |
| Task 10 | Assistance for Tendering and Award of Contracts |
| Task 11 | Dam Safety Plans |
| Task 12 | Emergency Response Plan (ERP) and Disaster Risk Management (DRM) |

**(2) Reporting Requirements and Time Schedule for Deliverables by the Consultant:**

The consultant shall discuss their interim findings at review meetings to be held with UAHEL management team on regular basis, and provide the following final deliverables.

- Inception Report within one and half (1.5) months of commencement of services covering activities as stipulated in Task 1.
- Design Report, including construction plan and updated cost estimate within five months (5) months of contract commencement of services.
- Updated Environmental and Social Management Plan (ESMP) and related Environmental and Social Protection Plans within five (5) months of contract commencement of services.
- Finalized Prequalification Documents for Civil and Hydromechanical works contract (s) within six (6) months of contract commencement of services
- Finalized Prequalification Documents for Electro-mechanical contract within six (6) months of contract commencement of services
- Finalized Detailed Design and Bidding Documents for Employer's Camp within seven (7) months of contract commencement of services
- Finalized Dam Safety Plans within seven (7) months of contract commencement of services.

- Finalized Emergency Response Plan (ERP) within seven (7) months of contract commencement of services.
- Finalized Tender Documents for Civil and Hydromechanical works contract(s) within nine (9) months of contract commencement of services.
- Finalized Bidding Documents for Electro-mechanical contract within nine (9) months of contract commencement of services.
- Finalized Detailed Design and Bidding Documents for Transmission Line Contract Employer's Camp within nine (9) months of contract commencement of services.
- The monthly progress report in agreed format covering all the activities of the consultant in the previous month within 15 days of the end of the reporting month.
- Trimester Report in agreed format summarizing all activities of the consultant in the previous trimester.

Note: *The months indicated above as per the original contract, will be shifted due to the delayed submission of Deliverables by the Consultant. The expected date shall be notified to the experts as and when available.*

**ANNEX C: Detailed Terms of Reference for the Tender Design, Preparation of Bidding Document, Construction Supervision and Post Construction Services for the Upper Arun Hydroelectric Project**

(To be attached separately).